Fraser River Estuary Management Program

A Recommended Waste Management Activity Plan

Waste Management Activity Program
October, 1990

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FRASER RIVER ESTUARY
MANAGEMENT PROGRAM

A RECOMMENDED
WASTE MANAGEMENT ACTIVITY PLAN

Prepared for the

Management Committee Executive
Fraser River Estuary Management Program

Prepared by the

Waste Management Activity Program
Working Group

October, 1990

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EXECUTIVE SUMMARY

The objective of the Waste Management Activity Program is to examine the nature of waste management concerns in the estuary, and develop activities to address these concerns. This report contains the Activity Plan which lists and discusses recommendations for pollution control activities in the Fraser estuary, and describes an implementation strategy for these activities. Appendices to this report summarize the legislation enabling waste management activities; the background and context of estuarine waste management including the natural characteristics of the Fraser; the nature of contaminants; and information and monitoring initiatives. More detail on contaminant loadings, issues, initiatives, remedies, and rationale for activities dealing with the various areas of concern is also given in the appendices.

Areas of concern are categorized by discharge type, based on concerns expressed by member agencies, technical experts, and the public, and are prioritized into (1) sewage treatment plants, (2) industrial effluents, (3) urban runoff and combined sewer overflows, (4) agricultural wastes and rural runoff, (5) groundwater contamination, and (6) miscellaneous wastes. Some areas of concern are estuary-wide issues common to a number of discharge types. These include special wastes, compliance, and enforcement.

Activity Plan

The activity plan is derived by considering the relative impact of the various contaminant sources and types on the Fraser estuary. Activities address: (1) guiding principles; (2) pollution abatement for each area of concern; (3) database management; (4) education and public awareness; (5) administration; and (6) research directions.

(1) **Guiding Principles:** Principles for pollution control in the Fraser estuary have been articulated in the past but these have not been drawn together into cohesive policy guidelines. It is recommended that proactive waste management policies be developed that aim to mitigate contaminant loadings to the Fraser estuary through use of the Best Available Control Technology or the Lowest Achievable Emission Rate, incorporate source control, recycling, or production methods that avoid creation of contaminants, and apply economic fees as an incentive to reduce loadings below permit standards. These principles are applied to recommendations following.

(2) **Pollution Abatement:** Some pollution abatement initiatives for pollution control in the Fraser estuary have already been implemented or are under development by responsible agencies. The activity plan recommends: the GVRD sewer use bylaw be completed and implemented, and upgrading strategies for Sewage Treatment Plants be concurrently developed; the annual permit fee structure under the Waste Management Act be restructured to incorporate waste surcharges, source control and treatment options be developed and implemented for stormwater; a household hazardous waste program be developed; the Agricultural Waste Regulation under the Waste Management Act and an agricultural code of good practice be completed and implemented; and that guidelines be developed and implemented for leachates, floating home, and shipping discharges.

(3) **Database Management:** There is a need for timely reporting of research and monitoring data. The plan recommends that agencies consider interagency compatibility and needs when developing or modifying computerized databases, and that annual data report summaries be provided to the FREMP office clearing house.

(4) **Education and Public Awareness:** Public involvement and awareness leads to voluntary compliance with the intent of pollution control regulations. The plan recommends that the public be informed and public interest groups be encouraged to make use of the FREMP office. Updating and more widely distributing the FREMP agency guide would assist this process, but more specific publications and awareness programs are needed.

Industry could be involved through technology transfer seminars and waste management audit procedures.

(5) **Administration:** Administrative procedures could be restructured to enhance waste management activities. The plan recommends that agencies be named to deal with specific aspects of pollution control; that Pollution Control Objectives be revised; that a surveillance and enforcement strategy be developed and implemented; that a B.C. special waste facility be constructed; and that FREMP be funded at a higher level.

(6) **Research Directions:** The plan recommends that certain specific research be undertaken in the areas of chronic and acute toxicity, air emissions and in laboratory analytic procedures. A research fund should be established.

Action Steps

The plan prioritizes the recommendations into three groups: for immediate action, for action over the next five years, and for action as resources allow. Implementation steps for the recommendations are discussed, as are budgetary considerations. Review of the Activity Plan after five years is recommended.

Summary of Goals and Strategies

Guiding Principles

R1 Reduce the entry of pollutants to the Fraser estuary through the use of Best Available Control Technology (BACT) for conventional pollutants and through the use of Lowest Achievable Emission Rate Technology (LAER) for toxic or hazardous pollutants.

R2 Implement source control, recycling, or production methods that avoid creation or discharge of wastes.

R3 Apply economic incentives to encourage resource conservation and reduce direct or indirect discharges of waste to the estuary.

Pollution Abatement

GOAL: To reduce pollutant discharges to the Fraser River estuary to a level achievable by Best Available Control Technology (BACT) for conventional pollutants, and by the Lowest Achievable Emission Rate (LAER) for toxic pollutants.

R4 Implement industrial and commercial sewer use source control.

R5 Upgrade the Annacis and Lulu Island Sewage Treatment Plants.

R6 Restructure the annual permit fee schedule set out in the Waste Management Fees Regulation of the Waste Management Act to incorporate effluent quantity and quality surcharges.

R7 Develop and implement source control and treatment options for urban runoff and combined sewer overflows.

R8 Implement a viable household hazardous waste collection and disposal program.

R9 Reduce waste loadings from agricultural sources.

R10 Control, collect, and treat leachates.

R11 Control contaminant loadings from sources such as floating homes, shipping, water contact structures, and upstream sources.

Database Management

GOAL: To enhance storage, retrieval, and reporting of monitoring and research data so that effective development of contaminant control programs is facilitated, and limited resources are effectively allocated.

R12 Consider interagency compatibility and needs when developing or modifying computerized databases.

R13 Provide annual data reports summarizing effluent discharge flows, total loadings, and quality to FREMP to be published as part of a periodic status of the estuary report.

Education and public awareness

GOAL: To raise public awareness and educate specific segments of the population, including farmers, woodwaste operators, industrial workers, and homeowners, enhancing voluntary pollution abatement and compliance with pollution control regulations.

R14 Keep public informed and encourage public interest group public awareness programs or initiatives to make use of the FREMP office.

R15 Revise, update, and publicize Agency Guide.

R16 Have regular technology transfer seminars.

R17 Develop a process to have companies conduct waste management audits.

Administration

GOAL: To enhance pollution control by streamlining or changing administrative procedures to incorporate a consistent body of pollution control regulation, policy, and administrative procedures.

R18 Name lead agencies to deal with areas of interpretative conflict or legislative inefficiency such as floating home and shipping discharges, and woodwaste.

R19 Revise all Pollution Control Objectives and establish criteria for their use.

R20 Develop a Surveillance and Enforcement Strategy for the estuary.

R21 Continue to develop guidelines regarding abatement of contaminants from specific sources.

R22 Construct a British Columbia Special Waste Facility.

R23 Staff and fund FREMP at a level that facilitates implementation of the Activity Program recommendations.

Research Directions

GOAL: To undertake research that supports implementation of waste management activities, helps develop options for policy and program alternatives, and improves analytical procedures for contaminant detection.

R24 Perform chronic toxicity and zones of influence characterization studies under a variety of river flow conditions.

R25 Perform research on environmental effects and pathways, areas of impact, and significance of air emissions on precipitation runoff quality.

R26 Prepare an inventory of farm types and agricultural waste discharge points for the FREMP area.

R27 Perform research regarding enhancement of laboratory procedures and functions.

R28 Establish a research fund.

Acknowledgments

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Acronyms

ADWF	Average Dry Weather Flow
AECB	Atomic Energy Control Board
AESP	Agricultural Environmental Services Program
ALR	Agricultural Land Reserve
BACT	Best Available Contol Technology
BAT	Best Available Technology
BOD5	Biochemical Oxygen Demand over 5 days
BNA	British North American [Act]
BPT	Best Practical Technology
CCEM	Canada Council of Environment Ministers
CEPA	Canadian Environmental Protection Act
COD	Chemical Oxygen Demand
CSO	Combined Sewer Overflow
DFO	Canada. Department of Fisheries and Oceans
DOE	Canada. Department of the Environment
EP	Canada. DOE. Environmental Protection
FREMP	Fraser River Estuary Management Program
FRES	Fraser River Estuary Study
FRHC	Fraser River Harbour Commission
GVRD	Greater Vancouver Regional District
GVS&DD	Greater Vancouver Sewerage and Drainage District
IDZ	Initial Dilution Zone
IWD	Canada. DOE. Inland Waters Directorate
LAER	Lowest Available Emission Technology
LWMP	Liquid Waste Management Plan
MBAS	Methylene Blue Active Substances
MOAF	B.C. Ministry of Agriculture and Fisheries
MOE	B.C. Ministry of Environment
MOH	B.C. Ministry of Health
MPN	Most Probable Number
NFHC	North Fraser Harbour Commission
NFR	Non-filterable Residue
PAH	Polycyclic (Polynuclear) Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl, Pollution Control Board
PCP	Pentachlorophenol
PEP	Provincial Emergency Program
PSWQA	Puget Sound Water Quality Authority
PWWF	Peak Wet Weather Flow
RIP	Refuse Incinerator Plant
RODAC	Regional Ocean Dumping Advisory Committee
SA	Sewerage Area
STP	Sewage Treatment Plant
SWAC	Special Waste Advisory Committee
TBT	Tributyl tin
TCMTB	2-(thiocyanomethylthio)-benzothiazole
TCP	Trichlorophenol
TIC	Total Inorganic Carbon
TOC	Total Organic Carbon
TTCP	Tetrachlorophenol
WMA	Waste Management Act
WMAP	Waste Management Activity Program
WMB	B.C. MOE. Waste Management Branch

(B.C. MOE. Environmental Protection as of June, 1990)

Abbreviations

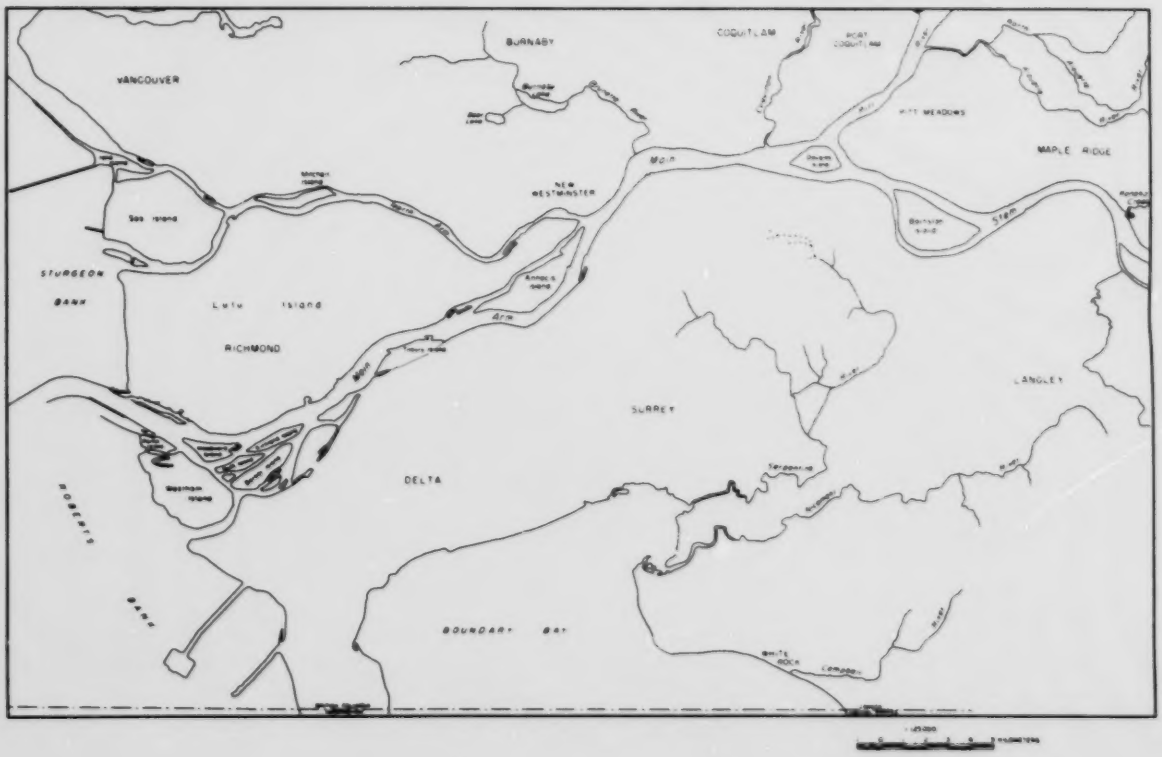
imp gal	Imperial gallon
kg	kilogram
kg/d	kilograms per day
km	kilometre
L	litre
m	metre
m^2	square metres
mL	millilitre
m/s	metres per second
m^3/d	cubic metres per day
m^3/s	cubic metres per second
mg/L	milligrams per litre
t/a	tonnes per annum

1. Introduction

The Fraser River estuary is an important location for industry, commerce, residences, and recreation. Wastes produced as a result of these activities negatively impact the environment. Through the estuary passes the largest natural salmon run in the world. The estuary is also home to the largest population of wintering waterfowl in Canada, and is the most important stopping point for one million migrating birds on the Pacific Flyway. As such, the estuary is of international importance, exceeding criteria for designation as a Ramsar site (Butler and Campbell, 1987). Sustainable development means finding and maintaining a balance between environment and economic benefits. Waste management is an important component of this: it attempts to deal with the wastes produced by development so that both economic and environmental benefits are maximized.

Chapter 1 of the "Waste Management Activity Plan" defines the mandate, goals, and objectives of the activity program, outlines the legislation enabling pollution control activities, briefly describes the contaminants of concern entering the Fraser estuary, and discusses the issues associated with each area of concern. The focus of the report is contained in Chapter 2 - Activity Plan, which sets out and discusses goals and strategies for waste management activities in the Fraser Estuary.

The "Technical Appendices" include a variety of information compiled during the preparation of the main report. Included is discussion of FREMP's administrative background, information on the natural characteristics of the Fraser River, waste characteristics, and the information and monitoring system currently in place. Legislation under which the government agencies derive their pollution control mandates is summarized, along with enforcement and compliance issues. For each major source of waste, an appendix discusses flow characteristics, contaminant loadings, initiatives taken by area agencies, the issues or concerns regarding each area, and remedies for dealing with the issues. The remedies sections describe various options that may or may not be developed and, as such, provide rationales for the activities discussed in Chapter 2.



1.1 The Waste Management Activity Program

The Fraser River Estuary Management Program (FREMP) was established in October 1985 by a federal-provincial agreement signed by the ministers of Environment Canada, Fisheries and Oceans Canada, the B.C. Ministry of Environment, and the chairmen of the Fraser River and North Fraser harbor commissions. The report, "An Implementation Strategy for the Fraser River Estuary Management Program" (FREMP Review Committee, 1984), prepared by Environment Canada and the B.C. Ministry of Environment, forms part of the agreement. The superordinate goal of the management program described in the report is "To provide the means for accommodating a growing population and economy, while maintaining the quality and productivity of the Fraser estuary's natural environment." This and subordinate goals were based on the Fraser River Estuary Study (FRES) Phase II final report (FRES Planning Committee, 1982). The management program was developed to provide a structured opportunity for ongoing cooperation in improving management of the Fraser River estuary. The implementation strategy is composed of three interrelated components: (1) goals and objectives, (2) the establishment of a Management Committee, and (3) the implementation of coordinated activities, including specific activity programs.

The activity programs develop goals and strategies for estuary-wide activities such as log storage or recreation. Each activity program work group has responsibility for establishing the priority of an activity with actual implementation to be carried out by the responsible agencies. The mandate of the work group is not legislated, but is a cooperative mandate assigned through the FREMP Agreement. **Ultimate authority for initiating activities under the Activity Program rests within the legislation of the participating agencies.**

The Waste Management Activity Program work group membership includes representatives from Environment Canada, Fisheries and Oceans Canada, the B.C. Ministry of Agriculture and Fisheries, the Greater Vancouver Regional District, the municipalities of Burnaby and Richmond, and the B.C. Ministry of Environment, Waste Management Branch, which acts as the lead agency. The activity program is closely associated with the FREMP Standing Committee on the Fraser River Water Quality Plan. Both programs are involved in the control and management of waste in the Fraser River, merging at the point where effluent enters the receiving environment. The Waste Management Activity Program is principally involved with managing waste streams before they enter the receiving environment and the water quality standing committee is responsible for assessing the effect of the waste once it has been discharged. A close working relationship is provided by members sitting with both programs.

The scope of the activities dealt with by the Waste Management Activity Program is determined by the types of waste management activities regulated or managed by the participating agencies. Thus, waste is considered to include all forms of organic or inorganic material which may enter water in the designated FREMP study area as a result of man's activities in the region, including discharges to air, land, or water. The significance of a waste is determined by its potential for causing an environmental impact. Wastes may include organic sewage, pesticides, storm drainage, industrial waste, sediment loads, leachates, special wastes, and other miscellaneous wastes.

The principal objective of the Waste Management Activity Program is **to review issues related to the management and control of discharges of harmful substances to the Fraser Estuary and to make recommendations to member agencies and the management committee for control of these discharges.** This is to be achieved through the development and implementation of a Waste Management Activity Plan, which is outlined in Chapter 2. Many current agency activities address tasks described in the Implementation Strategy (FREMP Review Committee, 1984), and are included in the Activity Plan as a coordinating measure. Implementation of activities is on a five-year time frame, a review of the Activity Plan after five years is recommended. Activities are compared to earlier Implementation Strategy goals and component tasks in Appendix 1.

1.2 Legislation

The legislative basis for action is effected through legislation at three government levels: federal, provincial, and municipal. Federally, the key acts are the Fisheries Act and the Canadian Environmental Protection Act, though other acts regulate certain aspects of pollution control or deleterious substances handling. The Fisheries Act applies to all waters frequented by fish and is the principal federal legislation protecting water quality and fish habitat. Sections 35 and 36 - 42 (formerly 31 and 33), in particular, provide for effective regulation of undertakings or of the deposition of deleterious substances. The Canadian Environmental Protection Act gives broad powers to regulate the handling and discharge of toxic substances to land, sea, or air.

Provincially, key acts are the Environmental Management Act, the Waste Management Act, and the Water Act. Under these acts, Pollution Control Objectives and Water Quality Objectives have been formulated to guide establishment of waste discharge conditions which are authorized through permits, plans, regulations, or orders. The Waste Management Act prohibits all waste discharges unless authorized by permit or specifically exempted. The Waste Management Act also includes a Special Waste Regulation.

The division of power among federal and provincial governments has led to some overlapping areas of jurisdiction. Generally, the federal government attempts to implement its regulations through provincial permits, but retains the right to act unilaterally when required.

The Municipal Act enables municipal governments to pass bylaws which may regulate some aspects of solid and liquid waste management, including sewer use, stormwater discharge, building code, construction, and dumping restrictions. The Waste Management Act enables the establishment of Sewer Control Areas and of Waste Management Areas following development of a provincially approved management plan. The Greater Vancouver Sewerage and Drainage District (GVS&DD) has been designated as a Sewage Control Area, and the Greater Vancouver Regional District (GVRD) is in the process of preparing a Liquid Waste Management Plan (LWMP) to satisfy requirements for designation as a Waste Management Area. A GVRD solid waste plan has been approved. The Waste Management Act also authorizes the GVRD to control air emissions within the regional district.

1.3 River Characteristics Affecting Waste Management

Natural river characteristics affecting waste management decisions are (1) the Fraser River has an annual flow regime that peaks during spring freshet with flow volumes that are more than 10 times greater than winter low flows, (2) the channel bifurcation at New Westminster directs almost 6 times as much volume into the Main Arm as to the North Arm, (3) tidal influences can extend upstream of New Westminster leading to standing water or reverse flow conditions in the estuary, and (4) the Fraser River has a high natural sediment load and a normal muddy appearance. These characteristics have consequences for waste management as the dispersion and residence time of contaminants varies depending on place, tidal stage, and time of year.

1.4 Waste Characteristics

The numerous contaminants that enter the estuary can be classified as conventional, metal, or organic pollutants. Conventional pollutants include coliform bacteria, suspended solids, oxygen demanding substances, oil and grease, nutrients, and detergents. A number of metals and inorganics containing metals are present in the waste streams entering the estuary. Organics include pesticides, PCBs, PAHs, chlorophenols, dioxins, and furans (Table 1).

Table 1 SUMMARY OF POLLUTANTS

CONVENTIONAL	ORGANIC
Coliforms	Phenols
Detergents	Chlorophenols:
Oil and Grease	Trichlorophenol (TCP)
Oxygen demanding substances:	Tetrachlorophenol (TTCP)
BOD_5	Pentachlorophenol (PCP)
COD	PCBs:
Nutrients:	Askarel (PCB + chlorinated benzenes)
Ammonia	Aroclor }
Nitrate	Inerteen } Common askarels
Nitrite	Pyranol }
Phosphorus	Dioxins and Furans
Total organic carbon (TOC)	Tributyltin (TBT)
Total inorganic carbon (TIC)	TCMTB
Suspended Solids (NFR)	Benzene
Boron	Toluene
Chloride	Phthalate esters
Chlorine residues	Polycyclic aromatic hydrocarbons (PAHs)
Cyanide	acenaphthene, acenaphthylene, anthracene, chrysene, fluoranthene, fluorene, naphthalene, perylene, phenanthrene, pyrene
Sulphate	Pesticides:
pH	Organochlorines:
Temperature	acrolein; aldrin; chlordane; DDT; disofol; dieldrin; endosulfan; endrin; heptachlor; hexachlorocyclohexanes (inc. lindane); methoxychlor; mirex
METALS	Organophosphates:
Aluminum	chloropyrifos; diazinon; disulfotor; malathion; methamidophos; methyl parathion; parathion; phorate
Arsenic	Carbimates:
Barium	aldicarb; bendiocarb; butylate; carbaryl; carbofuran; methomyl; vernolate
Cadmium	Anilides:
Chromium	alachlor
Cobalt	Benzoic acids:
Copper	dicamba
Iron	Nitroanilines:
Lead	trifluralin
Magnesium	Phenols:
Manganese	dinoseb
Mercury	Phenoxyaliphatic acids:
Molybdenum	2,4-D; 2,4,5-T
Nickel	Pyrethrins:
Selenium	fenvalerate
Silver	Pyridine-carboxylic acids:
Tin	triclopyr
Vanadium	Triazines:
Zinc	atrazine; prometon; simazine; toxaphene
Ammoniacal copper arsenate (ACA)	Uracils:
Chromated copper arsenate (CCA)	bromacil; tebuthiuron; terbacil
Copper-8-quinolinoate	Woodwaste leachates

Note: Many substances not listed here, especially organics, are also found in the estuary.

While conventional pollutants usually degrade, continuous discharge can chronically stress biological systems, and excessive amounts can cause detrimental, acute impacts. Organics and metals are usually toxic and/or persistent, and have been receiving more recent attention as priority pollutants. Some organics, such as the organochlorines, are soluble in oils, including animal fats, and tend to bioaccumulate. Others, soluble in water, do not persist in animal tissue to the same extent, but may have more immediate toxic impacts.

Some toxic materials bind to sediments or settle out as discrete particles. Estuaries act as filters or sinks for man-made or natural substances that are scavenged from the water column and deposited with sediments. Sedimented substances are not likely to become mobilized again unless disturbed, although high concentrations of toxic contaminants in sediments are associated with adverse impacts on bottom dwellers. High natural levels of some metals, such as are present in the Fraser River, may not be in forms that are as biologically available for uptake as those in man-made sources.

1.5 Areas of Concern

In this report waste management issues are divided into a number of categories which represent the concerns expressed by member agencies, by technical experts, and by the public. Some of these areas of concern affect all discharge types and activities, such as compliance, enforcement, and special wastes. Other areas of concern are categorized by type of discharge.

Waste discharge types have been prioritized by considering total discharge flows, contaminant loadings, and potential for environmental impact. Input from Environment Canada, Fisheries and Oceans Canada, Ministry of Environment, other federal and provincial agencies, regional districts, municipalities, and public interest groups has resulted in the following list of areas of concern and the issues affecting them:

a) **Special Wastes:** Special wastes are environmentally hazardous materials that require special treatment or storage prior to disposal. These wastes are generated from a wide variety of activities and include waste oils, solvents, acids and bases, contaminated sludges from treatment plants, heavy metals, chlorinated hydrocarbons, and pesticides. Special handling is required to conform to the Special Waste Regulation of the Waste Management Act. Implementation of some activities recommended in this report is inhibited by the lack of a special waste disposal facility in British Columbia. Small quantities of hazardous wastes, such as produced by households, are exempt from the Special Waste Regulation, but their proper disposal remains an issue.

b) **Compliance and Enforcement:** In the FREMP study area, enforcement action may be taken by several agencies. The primary ones are the provincial Ministry of Environment through the Waste Management Act and the Conservation Officer Service, and the federal environment and fisheries departments through the Fisheries Act and the Canadian Environmental Protection Act. Three compliance and enforcement components need to be addressed: random illegal discharges, ongoing unauthorized discharges, and authorized but noncomplying discharges. Techniques for attaining compliance employed by the Waste Management Branch include both negotiation and prosecution. While several agencies have mandates or programs in place, there is no enforcement or compliance strategy that is used in a cooperative manner by all agencies involved in FREMP, nor is there an estuary-wide surveillance strategy that would routinely uncover instances of illegal or unauthorized discharges.

c) **Sewage treatment plant effluents:** Most sewage treatment plant effluent is from the GVS&DD Iona, Annacis, and Lulu plants which treat domestic, industrial, commercial, and institutional wastes, as well as some stormwater content of combined sewers. About ten small private plants discharge secondary treated effluent.

The Iona sewage treatment plant (STP) now discharges through an 8 km long deep sea outfall to the Strait of Georgia, and has a much reduced impact on the estuary. The Annacis and Lulu Island STPs are the two largest point discharges of effluent to the estuary. Primary treatment at these plants is chiefly designed to deal with the BOD5 and suspended solids that is typical of domestic sewage. With chlorination, up to 99% of fecal coliforms are destroyed. Most metal and organic contaminant loadings are discharged to sewer by industry and commercial sources. Removal efficiencies for metals may approach 50% but lis generally less than 10% for the organics.

The continuous large flows from the Annacis and Lulu Island STPs lead to a substantial loading of a wide variety of contaminants to these two discrete points within the estuary. The GVS&DD STPs are only required to meet an interim level of the provincial Pollution Control Objectives for municipal type discharges. Federal officials generally feel these standards, especially for toxicity, are too low to ensure environmental protection, yet permit noncompliance for BOD5, oil and grease, some metals, and toxicity is common. Contaminants removed from effluent during treatment remain in the sludge. Sludge handling problems are increasing due to larger amounts of sludge produced and reduced storage areas and buffer zones. Also, source control options may result in industrial sludges that require disposal as special wastes.

d) **Industrial effluents:** These effluents include process water, cooling water, sewage, and potentially contaminated site runoff streams from forest product, chemical, food processing, metal plating and fabrication, petroleum, concrete production firms, and from port activities.

Industrial effluent flows range from a few high volume, high loading, high priority discharges to many low volume discharges. A wide variety of contaminants are collectively discharged to the estuary. While a fair amount of data exist, no clear idea of total loadings emerges due to omissions in the data collection and monitoring process. However, some idea of the greatest impact areas and significance of contaminants is known. Issues include toxicity of effluents, cumulative impacts of adjacent outfalls, and permit noncompliance.

e) **Urban runoff and combined sewer overflows:** These effluents arise from precipitation collected by storm sewers and discharged through numerous outfalls to the estuary. In parts of Vancouver, Burnaby, and New Westminster where combined sewers exist, system capacities may be exceeded during storm events resulting in overflows of stormwater combined with raw sewage. Separate systems deliver all sanitary sewage for treatment, but stormwater is generally discharged untreated to convenient water bodies. Stormwater is an important source of such contaminants as suspended solids, oil and grease, lead, other metals, and some organics. Stormwater is more difficult to treat than sewage or industrial effluents owing to flow fluctuations and its diffuse source.

f) **Agricultural wastes and rural runoff:** Runoff from fields and farm operations can negatively impact the receiving environment. Large parts of the FREMP study area are within agricultural land reserves and are used for berry farming, vegetable farms, pasture, grazing, livestock rearing, nurseries, market gardens, and hobby farms. Chemical fertilizer and pesticide use may result in contaminated runoff. Spreading of manure on fields may result in the discharge of oxygen demanding substances and fecal coliforms. The use of wood waste for road bed and feed lot covering may also contribute contaminants. The Serpentine and Nicomekl Rivers are particularly affected as these tend to have low stream discharges with low dissolved oxygen levels. Poor farm practices contribute to soil erosion. There is a lack of data regarding BOD, fertilizer, and pesticide pathways, and farm waste management practices.

g) **Groundwater contamination:** Domestic, agricultural, or industrial discharges to ground, septic tank discharges, and leachates from municipal landfills, woodwaste landfills, or refuse sites may contaminate groundwater. Old dump site and contaminated site remediation is an issue. Other issues are the lack of good data regarding leachate production,

composition, and impacts; regulation procedures; monitoring; surveillance; compliance; and enforcement.

h) **Miscellaneous wastes:** These are discharges of potentially deleterious substances from sources not included in other areas of concern, including raw sewage from floating homes or shipping, accidental spills, illegal dumping, atmospheric deposition, dredging and dumping of contaminated sediments, contaminants from upstream sources, and various other discharges. Contaminant loadings from these sources are generally minor, but significant localized impacts may result. Main issues are jurisdiction and regulation. A variety of legislation covers many of these cases, but varying intra-agency interpretation leads to inadequate regulation and enforcement.

1.6 Summary of Flows and Loadings

Sewage treatment plant discharges, urban runoff, and agricultural runoff are the three greatest sources of contaminated flows to the Fraser River estuary, contributing between 230 and 287 million cubic meters per year (Table 2). The maximum flow authorized by industrial permits for discharge to the estuary is 98 million cubic meters per year, though actual flows are probably less than this. Combined sewer overflows amount to about 22 million cubic meters per year. Flows from miscellaneous sources or to groundwater are low by comparison, ranging to 5.5 million cubic meters per year, though not all sources are accounted for.

Table 2 ESTIMATED ANNUAL FLOWS AND LOADINGS TO THE FRASER RIVER ESTUARY

Indicators (kg/year)	Sewage treatment plants	Industrial effluents	Urban runoff	Combined sewer overflows	Agricultural runoff
Flow (m^3/year)	275,279,000	93,242,000	287,000,000	22,300,000	230,700,000
BOD5	29,700,000	1,730,000	3,000,000	1,350,000	345,500
Suspended solids	16,967,000	2,640,000	10,600,000	1,350,000	345,500
Fecal coliforms *	2,900,000	na	4,500	91,000	66,000
Ammonia	3,200,000	40,150	33,945	87,600	460,000
Phosphorus	842,000	77,015	21,170	42,340	22,594
Copper	31,938	262.5	6,570	1,460	697
Lead	11,680	190.5	12,045	2,007	697
Zinc	39,785	515.9	21,535	1,825	697

* Most probable number x 10^{12} per year
na Not available

Over 80% of biochemical oxygen demanding substances, fecal coliforms, and nutrients are from the sewage treatment plants, which also contribute over 50% of suspended solid loadings. Most of the remaining suspended solid loadings are from urban runoff. Most metal loadings are from the sewage treatment plants though other sources, especially urban runoff, are significant.

The reliability of flow and loading data varies by the discharge source. Sewage treatment plants are comprehensively monitored, and data are reasonably reliable. Some contaminant loadings are underestimated as sample concentrations are occasionally below analytical detection limits. While industrial effluent permit requirements include monitoring, this monitoring is inconsistent between permits and rarely includes many of the contaminants of concern. Consequently, industrial effluent flow and loading data are less reliable than those for sewage treatment plants, and loadings are probably underestimated. Urban runoff and combined sewer overflow data are still less reliable. While some monitoring has been done for individual catchment basins, interpolation to the

whole estuary to derive flow and loading estimates introduces some uncertainty. Estimates of agricultural flows and loadings are based on few monitoring data, and are not reliable. Loadings are probably underestimated. Estimated flow and loadings data from miscellaneous sources or to groundwater are incomplete and are uncertain even when available. Recommendations to rectify these data deficiencies have been included in the activity plan.

1.7 References Cited

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Fraser River Estuary Management Program Review Committee. 1984. An Implementation Strategy for the Fraser River Estuary Management Program. Victoria: Ministry of Environment. 45p.

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2. Fraser River Estuary Waste Management Activity Plan

2.1 Introduction

The Fraser River Estuary Waste Management Activity Plan is built upon a review of existing information about areas of concern. It is organized into five areas: pollution abatement, database management, education and public awareness, administration, and research directions. Each area has an expressed goal, and strategies to achieve these goals are discussed. An introductory discussion of guiding principles for pollution control reviews the options for waste management and sets out a foundation for the activities included in the Activity Plan. Issues, jurisdiction, initiatives, and recommendations for each of these areas are summarized in Table 3. Rationales and justification for the recommendations, along with details on issues, initiatives, and remedies for each area of concern, are presented in the appendices.

In a later section, the activities are prioritized by considering the relative impacts of the various pollution sources and contaminant types on the water bodies making up the Fraser estuary. Agency responsibilities and a timetable for implementation are also presented.

2.2 Guiding Principles

The kinds of activities or programs that might be implemented depend on the policies of the various agencies with jurisdiction in the estuary. Principles, goals, or objectives for waste management or water quality have been articulated in the past, but these have not been drawn together into cohesive policy guidelines. There is a need for an overall philosophy and set of guiding principles for pollution control.

Past management principles have stated the need for actions that are cost effective, such that costs do not exceed the value of benefits expected to accrue. This approach is limited as many of the values associated with the Fraser estuary are intangibles for which quantifiable values are difficult to attach. Other values, such as health, have extremely high associated risk or uncertainty factors. The use of economic principles to safeguard the functioning of the ecosystem has a role in sustainable development, a policy adopted by many governments, including British Columbia, since publication in 1987 of *Our Common Future*, the report of the World Commission on Environment and Development.

The current pollution control policy in the Fraser estuary involves regulation based on ambient standards. Waste dischargers are required to obtain a permit, and permit holders are required to meet specified standards. Standards are determined on a site-by-site basis with reference to ambient conditions and guidance from both Pollution Control and Water Quality Objectives. Pollution Control Objectives are province-wide minimum waste quality standards formulated on the basis of technological, ecological, health, and economic considerations. Water Quality Objectives are policy statements of minimum water quality standards for particular water bodies, including those in the FREMP area. Water quality needs of particular environments may be such that discharges meeting pollution control objectives cannot be allowed. Alternatively, minimum pollution control standards might allow for enhancement of water quality conditions in specific areas. Consequently, Pollution Control and Water Quality Objectives are separate from each other and are applied with equal consideration in the estuary.

Very basically, policy options for pollution control are of three types: measures to enhance public awareness; provision of economic incentives; and regulation and enforcement. A major limitation of the current process is its static reactive character, it essentially attempts to manage waste through regulation alone. This process is further limited by a weak enforcement component. Needed is a stronger public awareness and

Table 3 ISSUES AND ACTION NEEDED FOR WASTE MANAGEMENT IN THE FRASER RIVER ESTUARY

A) POLLUTION ABATEMENT

ISSUE	EXPLANATION	JURISDICTION	CURRENT INITIATIVES	ACTION NEEDED	Rec No
Contaminant loading levels	High levels of contaminants enter river. Quality of effluents may be incompletely known. Sustainability of the water resource requires pollution control.	Fisheries Act, DFO and DOE Waste Management Act, MOE CEPA, DOE Pesticides Act, MOE Municipal Bylaws	GVRD Liquid Waste Management Plan Industrial source control and treatment facility upgrading. Waste Management Branch permit upgrading Agricultural Environmental Services Program	Strong statement of principles, policies, goals, and objectives to (1) reduce pollutant levels over time, (2) implement source control, recycling, and alternate production methods, and (3) introduce economic incentives for pollution abatement.	R1 R2 R3
Toxicity of effluents	Contaminants contained in effluents may be toxic to biota at discharge concentration levels. Federal and provincial officials disagree on IDZ toxicity. Permittees meeting permit requirements may still be subject to charges under the Fisheries Act.	Waste Management Act, MOE Fisheries Act, DFO and DOE CEPA, DOE	GVRD Liquid Waste Management Plan Waste Management Branch permit upgrading	Federal/provincial review of IDZ toxicity and agreement re. Pollution Control Objectives for toxicity. Protocol of Agreement on IDZ. Research needed on chronic toxicity.	R19 R24
Special wastes	Hazardous wastes in sewer systems pose safety hazard to sewer workers and the public. No disposal facilities lead to long-term storage or improper and dangerous disposal methods.	Special Waste Regulations, MOE Municipalities B.C. Hazardous Waste Management Corporation Act	GVRD Liquid Waste Management Plan Regional and municipal sewer use bylaws.	B.C. Special Waste facility needed.	R22
Sludge generation and handling	Sludge generated by source control programs may require handling as a special waste. Sludge handling and storage space at STPs is becoming limited.	Special Waste Regulations, MOE GVRD	GVRD Liquid Waste Management Plan Sludge Handling Guidelines	B.C. Special Waste facility needed. Implement Sludge Handling Guidelines	R22
Coliforms	Coliform levels from STPs and CSOs may be high. Also contributed from houseboat, shipping, septic tank, and agricultural waste sources.	Health Act, MOH Waste Management Act, MOE Canada Shipping Act, DOT	GVRD Liquid Waste Management Plan Chlorination of STP effluents is suspended during winter.	Regulate and/or treat coliform sources	R4,R5 R7 R18
Chlorophenates and other wood preservation chemicals	These toxic compounds contaminate surface or groundwaters draining from some forest and bulk loading sites.	CEPA, DOE Fisheries Act, DFO and DOE Waste Management Act, MOE	Chlorophenate Code of Good Practice, leading to regulation. TCMTB Code of Good Practice.	Regulate chlorophenol, TCMTB, and other wood preservation chemicals.	R21
North Arm degradation	Contaminants from stormwater, CSOs, and industries, and low reach assimilative capacity, lead to lower water quality in the North Arm.	Waste Management Act, MOE Fisheries Act, DFO and DOE	GVRD Liquid Waste Management Plan North Fraser Environment Plan Permit upgrading	Attach priority to pollution abatement activities for North Arm. Agency cooperation and coordination with NFHC environment plan.	
Tributary assimilative capacity	Urban and agricultural stormwater flows dominate Brunette, Serpentine, and Nicomekl tributaries.	Waste Management Act, MOE MOAF	Agriculture Code of Good Practice Agricul. Environ. Services Program	Implement higher standards for effluent quality. Attach higher priority to pollution abatement activities for these systems.	R7 R9
Combined sewer separation	Elimination of CSOs is at the expense of treating some stormwaters.	GVRD, municipalities	GVRD Liquid Waste Management Plan Municipal separation programs	Re-evaluate sewer separation when revising Pollution Control Objectives. Implement higher standards for effluent quality. Attach higher priority to pollution abatement activities for these systems. Explore storage/treatment options dealing with first 1 to 3 hours of stormwater flow.	R7 R9 R19
First flush effects	Initial discharges of urban and agricultural stormwaters may contain higher contaminant concentrations.	GVRD	GVRD Liquid Waste Management Plan		
Leachate generation	Leachates from woodwaste and solid waste dumps or landfills may contaminate groundwater or surface waters.	Waste Management Act, MOE Fisheries Act, DFO and DOE	GVRD Solid Waste Management Plan	Establish Code of Good Practice for woodwaste handling, re-evaluate woodwaste exemption from permitting system under WMA. Develop municipal bylaws to deal with woodwaste dumping and landfilling. Explore measures to encourage recycling of gyproc and other construction debris, and include proper disposal as part of building inspection. Revise Pollution Control Objectives for industrial refuse dumps.	R10 R19
Contaminant loadings to ground	Discharges to ground from industrial or domestic sources may contaminate groundwater.	Waste Management Act, MOE	Waste Management Branch permit system	Develop Pollution Control Objectives regulating quality of discharges to ground.	R19
Marinas and Wharves	Point sources for TBTs and other wood preservatives.	Health Act, MOH Waste Management Act, MOE Fisheries Act, DFO and DOE	EP monitoring	Continue monitoring to determine extent and impacts of problem. Develop a Code of Good Practice for TBT use.	R21
	Source of sewage or hold cleaning discharges.			Name agency responsible for regulation of houseboat sewage.	R18
Atmospheric Deposition	Air pollutants may be deposited to contaminate stormwater flows.	CEPA, DOE GVRD	Air pollution monitoring network Federal legislation for lead out of gasoline by Dec. 1,1990.	Research relationship between air emissions, air deposition, and runoff pollutant characteristics.	R25
Water Contact Structures	Toxic wood treatment compounds may be leached out.	CEPA, DOE Fisheries Act, DFO	EP Monitoring Code of Good Practice for bridge sandblasting	Continue monitoring to determine extent and impacts of the problem.	R21
Bridge Sandblasting	Paint particles and sand may impact fish resources.				
Spills	Accidental or illegal spills may contaminate groundwater or surface flows.	Canada Shipping Act, DOT Fisheries Act, DFO and DOE Waste Management Act, MOE	Emergency Management Activity Pgm EARP process for Vancouver Int'l Airport fuel barge facility	Enhance surveillance procedures. Coordinate with Emergency Management Activity Program.	R20
Dredging	Sediments are contaminant sinks.	CEPA, DOE IWD, DOE	Navigation and Dredging Activity Pgm RODAC	Coordinate with Navigation and Dredging Activity Program, and with Regional Ocean Dumping Advisory Committee.	
Log Handling	Source of wood debris and leachates. Destruction of habitat areas	NFHC FRHC	Log Management Activity Program Fraser River Debris Control Board	Coordinate with Log Management Activity Program.	

NOTE: Rec No is a cross reference to the recommendation number in Table 4 and in the text.

Table 3, cont ISSUES AND ACTION NEEDED FOR WASTE MANAGEMENT IN THE FRASER RIVER ESTUARY

B) DATABASE MANAGEMENT

ISSUE	EXPLANATION	JURISDICTION	CURRENT INITIATIVES	ACTION NEEDED	Rec No
Organization	Information in agency files may not be organized such that data can be easily analyzed or made available for interagency use.		Computerized databases	Agencies such as WMB and GVRD organize files or develop system to facilitate data analysis and sharing.	R12
Monitoring	Monitoring is needed to provide feedback for waste management decisions.	FREMP - Standing Committee on the Fraser River Water Quality Plan (SCFREWQP)	Working Committee on Fraser River Monitoring; LWMP Phase 2; Standing Committee on the Fraser River Water Quality Plan (SCFREWQP)	Monitoring efforts to be facilitated through SCFREWQP. Timely release of data.	R23
Coordination	Coordination of database management and monitoring efforts is needed to identify and address areas of concern in an effective and efficient manner.	FREMP - SCFREWQP	SCFREWQP annual workshop SCFREWQP annual summary of research and monitoring	Produce a periodic Status of the Estuary Report summarizing data collected, where held, in what form, analysis undertaken, and conclusions.	R13 R23

C) EDUCATION AND PUBLIC AWARENESS

ISSUE	EXPLANATION	JURISDICTION	CURRENT INITIATIVES	ACTION NEEDED	Rec No
Programs	General public and industry often not aware of waste management and water quality issues pertaining to the estuary.		Various newsletters Public hearings Hazardous waste pamphlets Fraser River Festival	Keep public informed. Encourage public interest groups to make use of FREMP clearing house. Inform FREMP of public awareness initiatives and use as a central repository for materials, factsheets, pamphlets, and publications. Emphasize the media. Hold technology transfer seminars. Have environmental management audits.	R14 R15 R16 R17 R23
Coordination	Needed to make the most effective and efficient use of available resources.	FREMP	FREMP Agency Guide FREMP State of Estuary Report		

D) ADMINISTRATION

ISSUE	EXPLANATION	JURISDICTION	CURRENT INITIATIVES	ACTION NEEDED	Rec No
Legislation	Legislation does not address some waste management concerns. Other forms of legislation than existing may be more effective.	Environment Canada Fisheries and Oceans Canada Ministry of Environment Ministry of Agriculture and Fisheries Ministry of Health Offence Act	Ongoing development of bylaws.	Review legislative interpretation of WMA and Health Act regarding houseboat sewage control. Develop municipal bylaws to regulate woodwaste.	R18
Pollution Control Objectives	Need to be revised to reflect current knowledge and bring up to date with technological capabilities.		Water Quality Objectives, MOE	Revise Pollution Control Objectives. Develop Pollution Control Objectives for municipal stormwater discharges, discharges to ground, and industrial refuse dumps.	R19
Compliance	Random illegal, regular unauthorized, or permit non-compliance may occur.		Waste Management Branch inspections and auditing	Develop a surveillance, compliance, and enforcement strategy for the Fraser with input from all FREMP member agencies. Procedures should include a coordinated surveillance and reporting system, mechanisms for dealing with illegal or unauthorized discharges, and a practical way of enforcing legislated requirements. Publicize names of those violating legislation or permits. Coordinate with public awareness initiatives. Jurisdictional protocal for enforcement agencies be established.	R20
Surveillance	No surveillance or enforcement strategy exists for the whole Fraser estuary.		NFHC Harbour Patrol FRHC Harbour Patrol		
Enforcement			MOE Enforcement Strategy DFO Enforcement Strategy MOE enforcement staff increased		
Coordination	Needed to avoid duplication of effort, contrary objectives, or a lack of legislation or enforcement in a particular area. FREMP is underfunded to carry out its mandate.	FREMP	DOE, DFO Memorandum of Understanding re. Fisheries Act	Production of a Status of the Estuary Report summarizing charges, orders, convictions, tickets, and other enforcement actions. Also including summaries of surveillance activities, relevant new legislation, permits issued. Enhance FREMP funding and manpower.	R20 R23

E) RESEARCH INITIATIVES

ISSUE	EXPLANATION	JURISDICTION	CURRENT INITIATIVES	ACTION NEEDED	Rec No
Lack of knowledge	Data is needed on environmental pathways, impacts, waste characterization, sources, contaminant effects, etc.		See SCFREWQP, annual Summary of Monitoring and Research Activities.	Perform chronic toxicity and zones of influence characterization studies. Investigate relationship between air emissions, air deposition, precipitation quality, and runoff quality. Prepare inventory of farm types and agricultural waste discharge points.	R24 R25 R26
Monitoring technology	Slow and expensive laboratory analysis is a main stumbling block in enforcement. Some pollutants with significant impacts are below current detection levels.			Perform research regarding enhancement of laboratory procedures to yield quicker, more sensitive, and cheaper analyses.	R27

NOTE: Rec No is a cross reference to the recommendation number in Table 4 and in the text.

education element to encourage voluntary waste reduction, followed by an incentives program to further induce waste producers to reduce discharges. Incentives use market forces rather than government coercion to achieve objectives. Generally, only after awareness and incentive programs prove unsatisfactory or do not achieve full results should new regulations or legislation be introduced. Continued research on ambient standards, technology, and program options allows refinement of past actions and strengthening of policy. The following three recommendations refer more specifically to guiding principles, which have been applied in the activity plan:

R1 Reduce the entry of pollutants to the Fraser estuary through the use of Best Available Control Technology (BACT) for conventional pollutants and through the use of Lowest Achievable Emission Rate Technology (LAER) for toxic or hazardous pollutants.

The cost of pollutant discharge to the estuary is significant in terms of toxicity and health risks, and in terms of uncertainty regarding consequences. It is desirable that loadings of contaminants be reduced to minimum levels. Two approaches to establishing these acceptable levels have been formulated by regulatory agencies. Receiving environmental standards are based on the quality of water required for specific uses such as drinking water, irrigation water, or recreation. Discharge standards can be established on maximum discharge limits as determined by that level achievable through technology. Both types of standards have merit as applied to the Waste Management Activity Program. However, regulated discharge levels are the method of choice for effluent and emission discharges. Receiving environment standards are then used as a backup to ensure that the discharge standards provide an adequate margin of safety for specific water uses.

Pollutants discharged to the Fraser River estuary can be considered conventional pollutants if they are not defined as toxic or hazardous under the Waste Management Act Special Waste Regulation or as Priority Chemicals under the Canadian Environmental Protection Act. Technology employed to remove conventional pollutants from waste streams should be based on Best Available Control Technology (BACT) and for toxic pollutants should be based on Lowest Achievable Emission Rate (LAER).

The Waste Management Activity Program recommends that a goal for reducing pollutant discharges be adopted to a level achievable through the use of BACT for conventional pollutants and LAER for toxic pollutants. Standards established for receiving environment quality should then be employed to safeguard specific water uses within the estuary.

R2 Implement source control, recycling, or production methods that avoid creation or discharge of wastes.

Preventive measures are usually more effective and less expensive than remedial measures. This principle ensures a proactive approach to waste management as production methods are employed that do not create pollutants, as recycling methods are used to minimize amounts of pollutants requiring disposal, and as pretreatment facilities are constructed that can more specifically deal with particular pollutant mixes than the end-of-line GVS&DD sewage treatment plants. In some cases, waste products can be perceived as resources in their own right, and efforts to market them can be economically feasible.

R3 Apply economic incentives to encourage resource conservation and reduce direct or indirect discharges of waste to the estuary.

A major rationale for utilizing economic incentives for pollution control is to correct failing resource allocation mechanisms. Specifically, producers do not enter environmental

damages into their operating cost calculations as these are borne by the public. Economic incentives consist of placing a price on these external effects so that the producer will be motivated to place no greater burden on the environment than is justified by the benefits received by society. Both industry and the public support the "polluter-pays" principle, with industry concerned that charges are applied equitably to themselves and their competitors. Once such charges are equitably distributed, industry will pass them on to the public. As the price of goods is higher, demand will be lower, production will be lower, as will the associated production of wastes. Thus the balance between costs and benefits is achieved. Determining the proper level of environmental cost is difficult, so continuous development or adjustment of policy is needed to reflect new knowledge.

2.3 Pollution Abatement

GOAL: To reduce pollutant discharges to the Fraser River estuary to a level achievable by Best Available Control Technology (BACT) for conventional pollutants, and by the Lowest Achievable Emission Rate (LAER) for toxic pollutants.

STRATEGIES:

R4 Implement industrial and commercial sewer use source control.

NEED: Source control pretreatment is usually the most effective and efficient way to reduce contaminant loadings to STPs, and reduce pass-through loadings to the estuary. Concerns for safety of sewer workers and the public, harmful impacts on the sewerage works, and upset of biological STP processes are also addressed. Preservation of STP sludge quality is enhanced through source control. Economic incentives, such as sewer use surcharges, are a proven method of reducing water consumption and contaminant loadings to sewer, and should be incorporated into a source control bylaw.

ACTIVITY: A Regional Sewer Use Bylaw is being developed by the GVRD and member municipalities under auspices of the GVRD Liquid Waste Management Plan.

R5 Upgrade the Annacis and Lulu Island Sewage Treatment Plants.

NEED: Current primary treatment only removes floating and settleable materials. Contaminants in colloidal or dissolved form pass through relatively untouched. While source control programs address industrial and commercial discharges to sewer, domestic discharges remain important sources of contaminants. Upgraded treatment is the only way to ensure consistent reduction or removal of environmentally significant contaminants.

ACTIVITY: Planning and pilot work to determine which upgrading option should be developed, and on what schedule, should proceed concurrent with the implementation of source control. Source control programs are a prerequisite to upgraded treatment facilities, so once source control is in place, facilities should be upgraded. The GVRD Liquid Waste Management Plan will investigate upgrading options. The Iona Island plant was upgraded in 1987 with a deep sea outfall. The need for further upgrading at the Iona plant should be based on results of the ongoing environmental monitoring. Monitoring results should be evaluated and made available in a timely manner.

R6 Restructure the annual permit fee schedule set out in the Waste Management Fees Regulation of the Waste Management Act to incorporate effluent quantity and quality surcharges.

NEED: Presently, fees are structured to recover administrative costs. They are based on industrial capacity for production of goods and may bear little relation to the amount of

effluent or contaminants discharged. They also may vary widely between industries with similar effluent flows. Basing the permit fees schedule on effluent volume and contaminant loading will provide an abatement incentive, in the same fashion that sewer use surcharges are a proven method of pollution control.

ACTIVITY: An amended Waste Management Fees Regulation should set out minimum standards that are technologically achievable for particular industries, and contain a surcharge schedule for various levels of effluent quality above minimum standards. These fees and the sewer use surcharges recommended for a sewer use bylaw (R4) should be coordinated to avoid inequity between competing industries. The new regulation would be phased in for the Fraser estuary area via a permit upgrading strategy that would include an implementation timetable.

R7 Develop and implement source control and treatment options for urban runoff and combined sewer overflows.

NEED: Urban runoff and combined sewer overflows contribute a volume of contaminated water equal to that for sewage treatment plants. Loadings of some pollutants, such as suspended solids and some metals, are similar for runoff and sewer outfalls. No treatment is currently being undertaken.

ACTIVITY: The GVRD LWMP will address options associated with upgrading storm sewer infrastructure. Pollution abatement for urban runoff and combined sewer overflows rests on implementation of source control and treatment options. Source control examples are street sweeping or vacuuming, infiltration systems, and controls on air emissions. Treatment options include storage tanks, treatment facilities, and sewer separation. Water conservation measures in conjunction with source control programs (R4) would assist CSO contaminant abatement by providing more stormwater treatment capacity in combined sewer areas. Submerged outfalls with diffusers would assist IDZ dilution and aesthetics as in the case for industrial discharges (R6).

R8 Implement a viable household hazardous waste collection and disposal program.

NEED: Improper disposal of household hazardous wastes continues partly because alternatives are not available or are impractical.

ACTIVITY: The B.C. Ministry of Environment, GVRD, and municipalities should cooperate to develop a household hazardous waste collection and disposal program.

R9 Reduce waste loadings from agricultural sources.

NEED: Agricultural waste concerns center on the entry of oxygen demanding substances, woodwaste leachates, nutrients, and pesticide residues to the estuary as contaminants in flows from field and farm operations. Generally, there is a lack of good information on agricultural waste practices, composition, sources, and environmental pathways. More research assessing environmental impact is needed.

ACTIVITY: Complete and implement the Agricultural Waste Control Regulation to the Waste Management Act and the Code of Agricultural Practice for Waste Management which are being developed by the Agricultural Waste Management Committee. A strong educational effort aimed at people who raise livestock is needed as a follow-up. Incentives for farmers to implement best management practices, and inspection or surveillance to monitor compliance should also be part of a follow-up process. The Waste Management Activity Program has requested that a more detailed Background Paper be prepared on agricultural waste issues and possible remedial strategies.

R10 Control, collect, and treat leachates.

NEED: Leachate generation from solid waste, industrial refuse, and woodwaste dumps or landfills is a source of ground and surface water contamination in the FREMP area. Current pollution abatement activities are limited to leachate collection at municipal landfills, and guidelines for woodwaste dumping. Research is needed to determine the amount of leachate actually contaminating groundwater flows. Further abatement actions are dependent upon development of enforceable regulations or bylaws as described in Section 2.6. Industrial discharges to ground may be permitted under the WMA, but contaminant limits are generally those applied to surface waters. Research to determine contaminant impacts is needed before pollution control objectives can be defined. Other research efforts are needed to determine the extent of chlorophenate and other wood preservative chemical impacts on groundwater.

ACTIVITY: Develop guidelines for best management practices. Other activities involve researching alternative uses for woodwaste and recyclable materials, guidelines for woodwaste land-filling, and monitoring programs for leachate contamination. The Waste Management Activity Program has requested that a more detailed Background Paper be prepared on groundwater contamination issues and possible remedial strategies.

R11 Control contaminant loadings from sources such as floating homes, shipping, water contact structures, and upstream sources.

NEED: As is the case for groundwater contamination, pollution abatement actions for miscellaneous waste sources depend on development or refinement of regulatory procedures (see Section 2.6). Research needs include examination of TBTs, similar water contact contaminants such as creosote which contains PAHs, and leachates from log handling activities. More emphasis should be placed on wastewater discharges from boats and shipping. Environmental effects and pathways, areas of impact, significance, and possible alternate materials or handling methods are all topics that should be examined.

ACTIVITY: Form a committee with representation from MOE, MOH, EP, and the affected municipalities. Purpose of the committee is to develop and implement strategies addressing these issues, including new regulation if necessary. The Waste Management Activity Program has requested that a more detailed Background Paper be prepared on miscellaneous waste issues and possible remedial strategies.

2.4 Database Management

GOAL: To enhance storage, retrieval, and reporting of monitoring and research data so that effective development of contaminant control programs is facilitated, and limited resources are effectively allocated.

STRATEGIES:

R12 Consider interagency compatibility and needs when developing or modifying computerized databases.

NEED: Several agencies routinely collect data regarding effluent quality, water quality, or contaminant loadings. Examples are WMB effluent and GVRD air emission permit files. Typically, data are collected to ensure permit requirements are being met. Use of WMB data to determine estuary-wide loading values or to analyze trends is difficult as they are contained in paper files, and because required data are not always collected. Inter-agency use is also difficult as the files are not in a form that can easily be referenced.

ACTIVITY: When developing or modifying computerized databases, agencies should consider formats compatible with other agency's systems and their needs. This will facilitate analysis and interagency cooperation.

R13 Provide annual data reports summarizing effluent discharge flows, total loadings, and quality to FREMP to be published as part of a periodic status of the estuary report.

NEED: There is no annual summary of pollution control activities or contaminant loadings which would serve a coordinating role and highlight waste management success or failures. The Standing Committee on the Fraser River Estuary Water Quality Plan gathers annual data on estuarine research and monitoring activities, and publishes an annual summary. A Status of the Estuary Report is issued every three years.

ACTIVITY: A waste management perspective could be added by including effluent flow and loading data in the Standing Committee reports. Alternately, agency summaries of monitoring and research done, data collected, where data are held and in what form, and progress made towards the overall Fraser Estuary Management Program water quality objectives should be made available at the FREMP office for publication.

2.5 Education and public awareness

GOAL: To raise public awareness and educate specific segments of the population, including farmers, woodwaste operators, industrial workers, and homeowners, thus enhancing voluntary pollution abatement and compliance with pollution control regulations.

STRATEGIES:

R14 Keep public informed and encourage public interest group awareness programs or initiatives to make use of the FREMP office.

NEED: Public interest groups can potentially reach more people than government agencies, especially if funded through grants. In general, effective public involvement is facilitated through proper notice, early access to information and those involved in the decision-making process, and follow up by decision makers. Some means for enhancing this process is needed. Public education requires an ongoing effort, and initiatives for this need to be encouraged.

ACTIVITY: As a central registry, the FREMP office should be informed of planned public awareness initiatives, and supplied with materials, information, factsheets, brochures, and pamphlets to be distributed to interested persons. FREMP needs to make interest groups aware that its office can act as a clearing house. A fund similar to the Puget Sound Public Involvement and Education Fund could facilitate awareness, provide for public access to hearings, meetings, or advisory processes, provide funding or establish awards for innovative public involvement initiatives, or subsidize community cleanup and monitoring efforts. FREMP, in cooperation with other groups, could more actively produce public information such as brochures, factsheets, press releases, videos, posters, and school curriculums. As radio, television, and print media are the main sources of information for most of the public, the media should be better informed through press kits, press releases, press conferences, and other means.

R15 Revise, update, and publicize Agency Guide.

NEED: Public awareness and involvement can be enhanced when those interested know where to address their concerns or complaints, or where to find more information.

ACTIVITY: FREMP issued an Agency Guide in 1987. This guide should be updated, revised to include public interest group contacts, and made more widely available. Agency waste hot lines where pollution complaints can be received should also be publicized.

R16 Have regular technology transfer seminars.

NEED: Many industries, especially small ones, may lack resources to keep abreast of best available or practical technologies or management practices that could result in resource conservation, waste reduction, and a more economical business.

ACTIVITY: Government/industry cooperation in sponsoring occasional technology transfer seminars would aid awareness. Topics could include metal finishing industry practices, sludge handling, and wood preservation techniques.

R17 Develop a process to have companies conduct waste management audits.

NEED: Site-specific resource conservation and waste reduction may be economically and environmentally practical, but not implemented due to lack of knowledge by owners or managers of the affected industry.

ACTIVITY: Industrial associations should be encouraged to assist in developing waste management audits for their members that would examine the industry's entire operation, and suggest ways that production methods, materials, or waste management operations could be changed or modified to result in overall lower waste production. Such audits could suggest a number of environmentally friendly options for the firm.

2.6 Administration

GOAL: To enhance pollution control by streamlining or changing administrative procedures to incorporate a consistent body of pollution control regulation, policy, and administrative procedures.

STRATEGIES:

R18 Name lead agencies to deal with areas of interpretative conflict or legislative inefficiency such as floating home and shipping discharges, and woodwaste.

NEED: While legislation covering all types of pollution exists in some form, interpretation of the legislation, or policies developed to carry out legislated mandates, may create difficulties in pollution abatement enforcement. An example of this is sewage discharges from floating homes where varying interpretation of the Health Act and the Waste Management Act inhibits control of floating home pollution. Shipping discharges could be regulated under the Canada Shipping Act. Also, the Waste Management Act does not deal effectively with the woodwaste issue. In addition to codes of practice and a review of exemptions for wood waste in the Waste Management Act, regional and municipal bylaws should be considered.

ACTIVITY: The various agencies involved in areas of contention should meet and form agreement on regulation.

R19 Revise all Pollution Control Objectives and establish criteria for their use.

NEED: Pollution Control Objectives are not directly enforceable by legislation. However, they are needed during the process of determining allowable waste quality levels.

Pollution Control Objectives are currently scheduled for revision and this revision should emphasize technology criteria for waste standards. More stringent standards may now be possible due to technological advances since the objectives were developed in the early 1970s. Modern technology can also identify and quantify previously undetectable pollutants, these materials should be addressed in revised objectives. Standards for a wide range of contaminants could be developed. Pollution Control Objectives should identify minimum waste quality standards that must be met by a permit holder, based on the best practical technology for that waste producer type. Economic incentives (R6) would be based on quality levels that are technologically achievable. More explicit upgrading timetables might be added, as well as more rigorous criteria for entry levels. Consideration should be given to the possibility and consequences of intermedia transfer of pollutants. Ecological criteria are also of importance if sustainable development is to be a reality. Criteria for use of Pollution Control Objectives with Water Quality Objectives might also be set out.

ACTIVITIES:

- ***Revise Objectives for Municipal Type Discharges to include stormwater requirements.***

Present objectives do not include requirements for stormwater quality, and requirements for sewer separation are outdated given current knowledge.

- ***Review permitting procedures for industrial discharges to ground to determine if pollution control objectives are desirable.***

There is no industrial equivalent to Guidelines for Municipal Effluent Application to Ground. Permit standards are based on the permit writers' best professional judgement.

- ***Revise Pollution Control Objectives for industrial refuse dumps to incorporate leachate quality criteria as a means of regulating materials that may be dumped.***

Current objectives address operation of the refuse sites only. No criteria for leachable materials are incorporated, though the Leachable Quality Criteria in Special Waste Regulations can be used.

R20 Develop a Surveillance and Enforcement Strategy for the estuary.

NEED: Current enforcement of waste management regulation is weak. A strategy needs to address three elements: illegal discharges, unauthorized discharges that need regulation, and noncomplying regulated discharges. A subcommittee with membership from the Waste Management Activity Program and the Standing Committee on the Fraser River Estuary Water Quality Plan has been formed to review enforcement and compliance issues.

ACTIVITIES:

- ***Develop an Estuary Patrol with a centralized reporting system.***

Personnel that regularly observe conditions in the estuary include federal fisheries officers, provincial conservation officers, WMB officers, NFHC and FRHC harbor patrols, GVRD parks staff, public interest advocates, and concerned citizens. As the beginnings of a surveillance and enforcement strategy for the estuary, a centralized reporting system that would provide these personnel with information on what to watch for, details to note, and a place to forward these reports for action could be provided. This process can be modelled on that of the North Fraser Harbour

Commission Harbour Patrols (Williams, 1988). Follow-up on reports is important. Action teams, perhaps similar to the 1984 Fraser River Task Force, should be considered.

- ***Establish an interagency enforcement protocol agreement.***

An additional step in developing a surveillance and enforcement strategy would be establishment of an enforcement protocol agreement between government levels. A set of guidelines should be developed.

- ***Publicize instances of legislative violation or noncompliance with permit conditions.***

Public notice of violations in the print or radio/television media would provide an incentive for industries to comply with regulations. This would also serve a public awareness function in educating the public regarding what constitutes an illegal act.

- ***Publish annual reports summarizing enforcement actions, charges laid, convictions obtained, unauthorized discharges regulated, permit noncompliance incidences, and pollution abatement orders issued.***

As is the case for contaminant loading data and public awareness initiatives, coordination through a central coordinating office is necessary. Surveillance and enforcement information would be supplied by agencies including DFO and DOE for fisheries violations, WMB for violations under the Waste Management Act, MOH for violations of the Health Act, and others as relevant given the activities detailed elsewhere in this activity plan.

R21 Continue to develop guidelines regarding abatement of contaminants from specific sources.

NEED: The use of many toxic chemicals results in detrimental impacts when discharged to the environment.

ACTIVITY: An Anti-Sapstain Chemical Waste Regulation to the Waste Management Act for chlorophenols, TCMTB, and other wood preservation chemicals became effective Nov. 1, 1989. Regulations or codes-of-good-practice are also being developed for bridge sandblasting, use of TBTs in marinas, and practices in shipyards. Forty-four compounds or compound groups have been listed on the Canadian Environmental Protection Act Priority Substances List, and will be assessed for toxicity over the next five years with regulations developed as required.

R22 Construct a British Columbia Special Waste Facility.

NEED: A special waste facility in British Columbia is urgently needed to properly handle special wastes generated by programs such as sewer use restrictions, source control, industrial pretreatment, household hazardous waste programs, and to treat special wastes currently being stored.

ACTIVITY: The B.C. Ministry of Environment is reviewing special waste disposal methods and sites. A B.C. Hazardous Waste Management Corporation was formed in June, 1990 to manage special waste issues..

R23 Staff and fund FREMP at a level that facilitates implementation of the Activity Program recommendations.

NEED: Both the Fraser River Estuary Management Program and the FREMP Secretariat are underfunded and understaffed. Database coordination, public involvement, and education recommendations made in this activity plan will require more resources for FREMP if they are to be implemented.

ACTIVITY: The current FREMP agreement expires in 1990. Parties to the FREMP agreement are negotiating the terms of its continuation.

2.7 Research Directions

GOAL: To undertake research that supports implementation of waste management activities, helps develop options for policy and program alternatives, and improves analytical procedures for contaminant detection.

STRATEGIES:

R24 Perform chronic toxicity and zones of influence characterization studies under a variety of river flow conditions.

NEED: This is identified as a top priority for research into STP effluent effects, but work should be done for all discharge types.

ACTIVITY: Federal, provincial, and regional agencies should undertake or continue research.

R25 Perform research on environmental effects and pathways, areas of impact, and significance of air emissions on precipitation runoff quality.

NEED: Air deposition or washout of atmospheric pollutants is a main source of contaminants in urban runoff, little site-specific knowledge exists of the potential for this intermedia transfer of contaminants.

ACTIVITY: Federal, provincial, and regional agencies should undertake or continue research.

R26 Prepare an inventory of farm types and agricultural waste discharge points for the FREMP area.

NEED: Such an inventory would form the basis for further research which should include an assessment of the potential for release of oxygen demanding substances, nutrients, and pesticide residues. Characterization of stormwater from an agricultural basin is recommended.

ACTIVITY: The Ministry of Agriculture and Fisheries has requested funding from the National Agriculture Strategy for Soil and Water program.

R27 Perform research regarding enhancement of laboratory procedures and functions.

NEED: Laboratory services are a compliance and enforcement bottleneck due to the amount of time and the cost involved in analyzing samples. In some cases, analytical

procedures do not exist for contaminants that may be present in the environment, or detection limits are not low enough to properly evaluate environmental loadings.

ACTIVITY: Direct research towards increasing analytical procedure effectiveness, reducing costs, and lowering detection limits.

R28 Establish a research fund.

NEED: Research into areas of concern for waste management should be encouraged.

ACTIVITY: This fund would be available to provide grants or awards to those undertaking related or innovative research into topics of concern to waste management in the Fraser estuary. Possibilities include funding for student papers or theses on economic justification of policy alternatives, development of practical policy options, analysis or evaluation of programs, or comparative studies of other jurisdictions or areas. Such a fund could be shared among the various activity programs, and could also enhance public awareness of Fraser River estuary issues and concerns.

2.8 Action Steps

The above recommendations have been assigned one of three priorities by the Waste Management Activity Program working group. First priority recommendations, for immediate action by the responsible agency, include sewer use source control, restructuring permit fees and introducing surcharges for direct discharges, implementation of the agricultural code of good practice currently being developed, naming of agencies responsible for pollution control so that all areas are covered, revision of Pollution Control Objectives, development of a surveillance and enforcement strategy, and establishment of a special waste facility in British Columbia. The second priority is for development and implementation prior to 1995 of sewage treatment plant upgrading, urban runoff and combined sewer overflow treatment, development and implementation of guidelines for leachates, shipping discharges, and floating home wastes, development of agency databases, development of public awareness programs, continued investigation and development of guidelines for priority substances, an inventory of farm types and discharges, and investigation of the relationship between air emissions and runoff quality. Third and lowest priority items, for development and implementation by the responsible agency as its resources allow, include provision of annual data reports, a revised agency guide, an increase in FREMP resources, continued chronic toxicity and zones of influence research, and continued enhancement of laboratory analytic procedures (Table 4).

The next action required towards implementation of each recommendation has also been identified. Often the step required is beyond the authority of the Waste Management Activity Program working group, and input from the FREMP executive or agency decision makers is needed. Following is a discussion of the action steps required for the recommendations in the three priority groups.

2.8.1 Action Steps for First Priority Recommendations:

A sewer use source control bylaw is being developed by the GVRD and member municipalities as part of the Liquid Waste Management Plan. Implementation is scheduled as part of that plan.

Restructuring permit fees requires direction and commitment from the Ministry of Environment. Given this commitment, restructured fees and an upgrading strategy could be implemented during 1991-1992.

Table 4 WASTE MANAGEMENT ACTIVITY PROGRAM ACTION PLAN

A) POLLUTION ABATEMENT

RECOMMENDATION	MANDATE	PRIORITY	ACTION STEP	SCHEDULE
STPs:				
R4 Implement Source Control	WMA (Sec 17), GVS&DD Act	1	Part of GVRD LWMP	Phase II completed by 1991
R5 STP Upgrading	WMA (Sec 8a)	2	Part of GVRD LWMP Funding agreement	Planning: 1989-1991 Construction 1991-1996
Industrial Effluents:				
R6 Restructure Permit Fee Schedule	WMA (Sec 8e, 11)	1	Needs direction from decision maker	Develop policy - 1990; Implement - 1991
Urban Runoff and Combined Sewer Overflows				
R7 LWMP to Review Options and Implement ASAP	WMA, GVS&DD ACT	2	Part of GVRD LWMP	Phase II completed by 1991
Household Hazardous Wastes				
R8 Household Hazardous Waste Collection Program	WMA B.C. Haz. Waste Mgmt. Corp. Act	2	Coordination between provincial, regional, and municipal governments	Ongoing
Agricultural Wastes and Rural Runoff				
R9 Agricultural Waste Control Regulations and Code of Practice	WMA	1	Implementation of committee decisions	Ongoing, expected by 1990
Groundwater Contamination				
R10 Control, Collect, and Treat Leachates.	WMA	2	Develop regulations or guidelines where required	Ongoing
Miscellaneous Wastes				
R11 Amend Canada Shipping Act Develop and Implement Houseboat Waste Guidelines	Canada Shipping Act WMA (Sec 7 - not in force) Health Act	2	Develop regulations or guidelines where required	Ongoing

B) DATABASE MANAGEMENT

RECOMMENDATION	MANDATE	PRIORITY	ACTION STEP	SCHEDULE
R12 Develop and Manage Agency Databases	EMA, etc	2	Needs direction from decision maker	
R13 Provide Annual Data Reports		3	Needs direction from decision maker	Status of Estuary Report planned for 1990

C) EDUCATION AND PUBLIC AWARENESS

RECOMMENDATION	MANDATE	PRIORITY	ACTION STEP	SCHEDULE
R14 Active Public Awareness Programs		2	Develop guidelines where required	Ongoing
R15 Directory of Agency Contacts		3	FREMP initiative	As resources allow
R16 Hold Technology Transfer Seminars		3		
R17 Arrange Waste Management Audits		3		

Table 4, con't WASTE MANAGEMENT ACTIVITY PROGRAM ACTION PLAN

D) ADMINISTRATION

RECOMMENDATION	MANDATE	PRIORITY	ACTION STEP	SCHEDULE
R18 Name Agencies Responsible for Specific Pollutants	Various	1	Needs direction from decision maker	1990
R19 Revise Pollution Control Objectives	WMA	1	Needs direction from decision maker	Scheduled
R20 Develop Surveillance and Enforcement Strategy	EMA, WMA, CEPA, Fisheries Act	1	Needs direction from decision maker	Ongoing
R21 Continued Development of Guidelines	EMA, WMA, CEPA	2	Periodic review	Ongoing
R22 Special Waste Facility	WMA, Haz. Waste Mgt. Corp. Act	1	Needs new impetus/commitment	1991
R23 Increase FREMP resources.		3	Include in current negotiations	1990

E) RESEARCH DIRECTIONS

RECOMMENDATION	MANDATE	PRIORITY	ACTION STEP	SCHEDULE
R24 Chronic Toxicity and Zones of Influence Research	Various	3	Periodic review	Ongoing
R25 Investigate Air Emission and Runoff Quality Relation		2	Responsible agency to schedule as project	Ongoing
R26 Inventory of Farm types and Discharges		2	Responsible agency to schedule as project	1990
R27 Enhance Laboratory Procedures and Functions		3	Responsible agency to schedule as project	Ongoing
R28 Establish Research Fund		3	Needs direction from decision maker	1990

PRIORITY LEVELS:

1 - Immediate action
2 - Develop and implement over next five years.
3 - Develop and implement as resources allow.

Naming agencies responsible for pollution control requires prior agreement and commitment from the agencies named, and needs to be achieved through discussions among the responsible agencies. Current responsibilities are summarized in Table 5.

Revision of Pollution Control Objectives requires direction and commitment from the Ministry of Environment. A surveillance and enforcement strategy could be further developed by the Waste Management Activity Program work group.

The B.C. Special Waste Facility requires action from the Ministry of Environment and the new B.C. Hazardous Waste Management Corporation.

2.8.2 Action Steps for Second Priority Recommendations:

The GVRD has committed itself to sewer treatment plant upgrading depending on satisfactory funding arrangements between regional, provincial, and federal government levels. This is part of the GVRD LWMP process, as is urban runoff control and combined sewer overflow treatment.

Developing computerized agency databases requires direction and commitment from the relevant level of each affected agency.

Other second priority recommendations all require direction from the responsible decision maker regarding implementation and scheduling. These might be ongoing projects for which periodic review is required.

2.8.3 Action Steps for Third Priority Recommendations:

Third priority recommendations primarily require commitment from the responsible agency, and depend on the resources available to that agency. Recommendations for increased FREMP funding and public awareness initiatives are part of current negotiations regarding the renewal of the FREMP agreement. Research projects require budgeting and scheduling by interested agencies.

2.8.4 Costing:

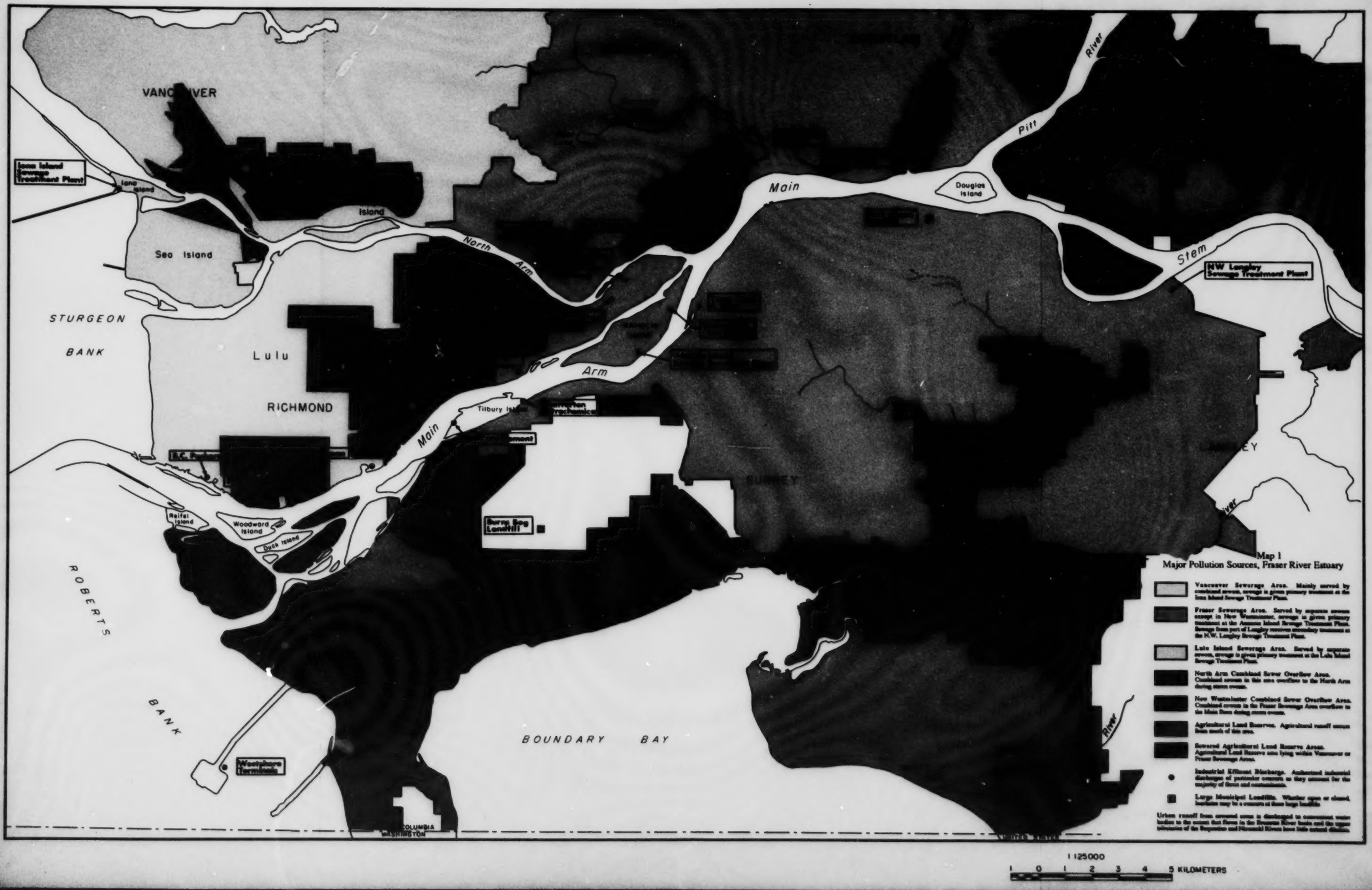
Few cost figures are available for these recommendations. These need to be developed by the affected agency. Some projects or initiatives would be funded by departmental operating budgets, others would require cost-sharing negotiations. Federal, provincial, regional, and municipal governments need to agree on cost sharing for capital expenditures such as sewage treatment plant upgrading. The practicality of placing funds raised from initiatives such as surcharges or pollution fines in an environmental fund rather than general revenue should be considered.

Table 5 REGULATORY RESPONSIBILITIES FOR WASTE MANAGEMENT IN THE FRASER ESTUARY

Area	Agency Responsible	Legislation	Comments
Discharges to sewer	GVS&DD Municipalities	GVS&DD Act Municipal Act WMA (sec 17)	Trunk lines Local lines LWMP being developed
Sludges	WMB	WMA	Sludge handling guidelines being developed
Effluents	WMB	WMA	All direct discharges require permit
Urban runoff	Municipalities	Municipal Act WMA (sec 17)	LWMP being developed
Air emissions	GVRD, WMB	WMA	GVRD in region via WMA Sec 19; WMB for areas other than GVRD
Combined sewer overflows	GVS&DD	GVS&DD Act WMA (sec 17)	LWMP being developed
Pesticides	MOE	Pesticides Act	
Fertilizers	MOAF	Fertilizer Act	
Agricultural discharges	MOAF, WMB		Class B exemption under WMA Regulation Regulation and Code of Practice under development.
Solid waste	GVRD, WMB	WMA	GVRD for municipal waste, SWMP in effect; WMB for other municipalities and industrial wastes.
Woodwaste	WMB	WMA	Class C exemption under WMA Regulation
Discharges to ground	WMB	WMA	
Wood preservatives	WMB	WMA	Anti-Sapstain Chemical Waste Regulation effective Nov 1, 1989
Bridge sandblasting	EP, DFO		Code of Good Practice
Houseboat discharges	WMB, MOH	WMA, Health Act	Class A exemption under WMA Regulation WMA Sec 7 - not in force Health Act: Sec 2 - not being enforced
Shipping discharges	MOT, WMB	Can. Shipping Act WMA	WMA Sec 7 - not in force
Contaminated sediment dredging	FRHC, NFHC VPC, DFO	WMA, CEPA Fisheries Act	PWC acts as contractor only
Ocean dumping	EP	CEPA	Dump sites on outer estuary
Special Wastes	MOE	Special Waste Reg.	
Spills	EP, MOE	Fisheries Act, WMA	Spills Reporting Regulation

Acronyms:

CEPA	Canada Environmental Protection Act	MOAF	Ministry of Agriculture and Fisheries
DFO	Department of Fisheries and Oceans	MOT	Ministry of Transport
DOE	Department of Environment	NFHC	North Fraser Harbour Commission
EP	Environmental Protection, DOE	PWC	Public Works Canada
FRHC	Fraser River Harbour Commission	WMA	Waste Management Act
GVRD	Greater Vancouver Regional District	WMB	Waste Management Branch, MOE
GVS&DD	Greater Vancouver Sewerage and Drainage District	VPC	Vancouver Ports Corporation



Map 1
Major Pollution Sources, Fraser River Estuary

Vancouver Sewerage Area. Mainly served by combined sewers, sewage is given primary treatment at the Iona Island Sewage Treatment Plant.

Fraser Sewerage Area. Served by separate sewers except in New Westminster, sewage is given primary treatment at the Annacis Island Sewage Treatment Plant. Sewage from part of Langley receives secondary treatment at the N.W. Langley Sewage Treatment Plant.

Lulu Island Sewerage Area. Served by separate sewers, sewage is given primary treatment at the Lulu Island Sewage Treatment Plant.

North Arm Combined Sewer Overflow Area. Combined sewers in this area overflow to the North Arm during storm events.

New Westminster Combined Sewer Overflow Area. Combined sewers in the Fraser Sewerage Area overflow to the Main Stem during storm events.

Agricultural Land Reserve. Agricultural runoff enters from much of this area.

Sewered Agricultural Land Reserve Areas. Agricultural Land Reserve area lying within Vancouver or Fraser Sewerage Areas.

Industrial Effluent Discharge. Authorized industrial discharges of particular concern as they account for the majority of flows and contaminants.

Large Municipal Landfills. Whether open or closed, landfills may be a concern as these large landfills

Urban runoff from sewered areas is discharged to conventional water bodies to the extent that flows in the Fraserview River basin and the upper tributaries of the Serpentine and Nicomekl Rivers have little natural dilution.

Appendix 1 Administrative Structure

The Fraser River Estuary Management Program (FREMP) was established by an agreement between the federal Department of the Environment, the Department of Fisheries and Oceans, the British Columbia Ministry of Environment, the Fraser River Harbour Commission, and the North Fraser Harbour Commission in October 1985 following preparation of "An Implementation Strategy for the Fraser River Estuary Management Program" by the Fraser River Estuary Management Program Review Committee (Table 1.1). The superordinate goal of the management program described in the report was "To provide the means for accommodating a growing population and economy, while maintaining the quality and productivity of the Fraser estuary's natural environment" (FREMP Review Committee, 1984). This and subordinate goals were developed out of the Fraser River Estuary Study (FRES), a five year interagency review of the management needs of the Fraser estuary. FREMP was developed to provide a structured opportunity for ongoing cooperation in improving management of the Fraser Estuary. The implementation strategy contains three interrelated components: goals and objectives, the establishment of a Management Committee, and the implementation of coordinated activities. The Management Committee consists of a widely based representational forum with coordination and leadership provided by a five member executive (Figure 1.1). Coordinated activities include a coordinated review process, an information system, specific activity programs, a water quality plan, and area plans.

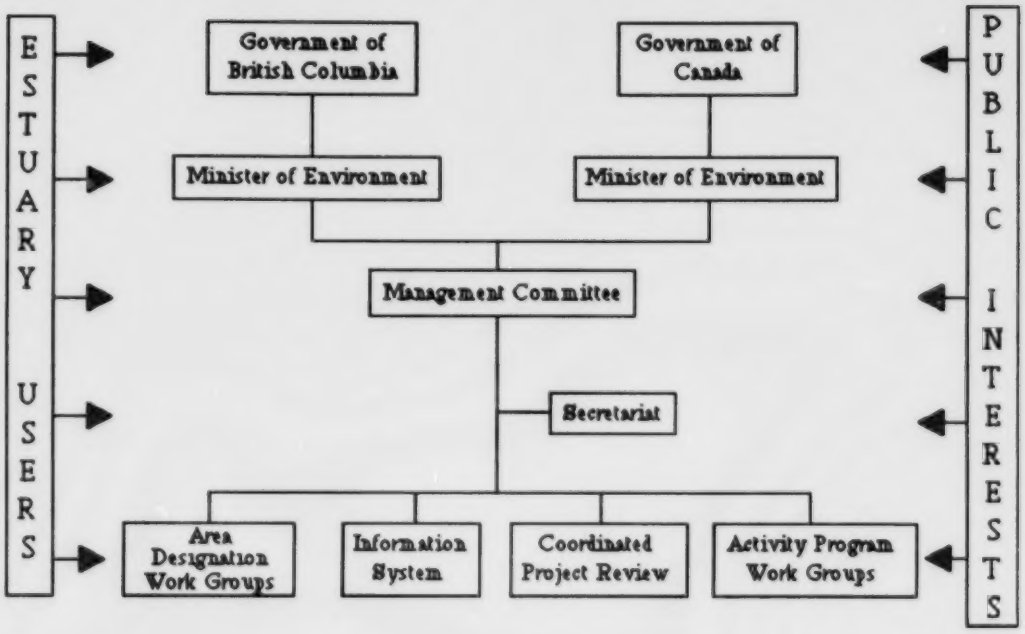
Table 1.1 EVENTS LEADING TO FORMATION OF FREMP

1977 - 1978	Fraser River Estuary Study, Phase 1
October, 1979	Management Program proposed under agreement between Government of Canada and Government of British Columbia
1979 - 1982	Fraser River Estuary Study, Phase 2
March, 1982	"A Living River by the Door: A Proposed Management Program for the Fraser River Estuary" published
May, 1984	"An Implementation Strategy for the the Fraser River Estuary Management Program" published
October, 1985	"An Agreement Respecting A Fraser River Management Program" signed by Environment Canada, Fisheries and Oceans Canada, the British Columbia Ministry of Environment, the Fraser River Harbour Commission, and the North Fraser Harbour Commission

Activity programs, prepared by working groups comprised of agency and user group representatives, are intended to prepare strategies that address estuary-wide activities such as log storage or recreation. By examining the existing nature of an estuary-wide activity, its effects on the estuary, and its forecast requirements from environmental, social, and economic perspectives, guidelines and recommendations for consideration by all decision-makers in the estuary are to be prepared. A designated agency is responsible for delivering each activity program on schedule and according to specified terms of reference. The Management Committee supervises and coordinates the preparation of various programs, ensuring compatibility with the overall management strategy.

The Waste Management Activity Program is one of these activity programs. The work group membership includes representatives from Environment Canada, Fisheries and Oceans Canada, the B.C. Ministry of Agriculture and Fisheries, the Greater Vancouver Regional District, the municipalities of Burnaby and Richmond, and the B.C. Ministry of Environment, Waste Management Branch, which acts as the lead agency. The original terms of reference, objectives, and component tasks as specified in the Implementation Strategy have been redrafted to reflect the present status of the components of the activity program, and developed in accord with mandates, responsibilities, and activities which are presently operational for managing waste in the Fraser Estuary.

Figure 1.1 ORGANIZATIONAL STRUCTURE OF THE FRASER RIVER ESTUARY MANAGEMENT PROGRAM



COMMITTEE STRUCTURE

EXECUTIVE

Ministry of Environment
Environment Canada
Fisheries and Oceans Canada
North Fraser Harbour Commission
Fraser River Harbour Commission

MEMBERS AT LARGE

Port of Vancouver
Public Works Canada
Transport Canada
Ministry of Agriculture and Fisheries
Ministry of Crown Lands
Ministry of Parks
Ministry of Transportation and Highways
Central Fraser Valley Regional District
Dewdney-Alouette Regional District
Greater Vancouver Regional District
Burnaby
Coquitlam
Delta
Langley
Maple Ridge
New Westminster
Port Coquitlam
Pitt Meadows
Richmond
Surrey
Vancouver
White Rock
Coquitlam Indian Band
Katzie Indian Band
Musqueam Indian Band
Tsawwassen Indian Band
Matsqui Indian Band
Semiahmoo Indian Band

1.1 Terms of Reference

Introduction

The terms of reference for the Waste Management Activity Program formulated under the implementation strategy prepared by the Fraser River Estuary Management Program Review Committee included two objectives and six component tasks (Table 1.2). The specific terms of reference discussed below have been derived from this document by the working group responsible for the activity program.

Table 1.2 IMPLEMENTATION STRATEGY GOALS AND OBJECTIVES FOR THE WASTE MANAGEMENT ACTIVITY PROGRAM

Objectives

1. To maintain ambient Water Quality objectives throughout the Fraser estuary and where degraded to improve water quality to achieve ambient objectives by:
   a) Halting unregulated discharges and illegal dumping of hazardous wastes.
   b) Controlling pollution contributed by storm water discharges.
   c) Meeting long term solid waste management needs.
   d) Reducing or eliminating fecal coliforms.

2. To provide a comprehensive program for pollution source control, treatment and disposal of municipal wastes, industrial and toxic wastes, solid waste disposal, and handling of urban and rural run-off.

Component Tasks

1. Develop a source control program for municipal and industrial effluents.
2. Establish criteria for the siting of a hazardous waste disposal and/or collection facility.
3. Develop waste management compliance and upgrading schedules based on attaining and maintaining ambient water quality objectives.
4. Identify present methods and trends in treatment and disposal of liquid and solid wastes and recommend cost-effective means to improve waste treatment and disposal.
5. Identify problem spots throughout the estuary by using water quality and biota as indicators and make recommendations to solve the problems.
6. Other tasks as identified.

(Source: FREMP Review Committee, 1984, pages 36 - 37)

Purpose

Terms of reference have been established to provide a framework for delivery of the objectives of the activity program. The basis on which all of the work will be carried out needs to be clearly defined so that the participating agencies understand the process and mechanisms which are guiding the work. In order to achieve this, the mandate of the program, its scope, and the process under which it operates have been specified in the terms of reference. The relationship of this activity program to other activity programs, to other FREMP committees, and to other agencies has also been identified in these terms of reference in order to clarify the interrelationships between the many participating groups responsible for waste management in the Fraser Estuary.

Mandate

The mandate assigned to FREMP and to the activity programs, as outlined in the agreement, stresses a cooperative system whereby all affected parties have an opportunity to influence decisions within the existing framework of management responsibilities. The Management Committee provides the organizational mechanism to coordinate the achievement of goals and objectives of the Fraser Estuary Management Program. This is accomplished through the implementation of specific activities which are coordinated through the individual activity program working groups. The responsibility for establishing the priorities of these activities is left with the working group. The mandate of the working group is not a legislated mandate but rather a cooperative mandate assigned through the FREMP Agreement. **Ultimate authority for initiating activities under the Activity Program**

rests within the legislation of the participating agencies. The detail of this legislated authority has been presented in the report of the Standing Committee on the Fraser River Water Quality Plan (1987), and summarized in Appendix 5 of this report.

Scope

The scope of the activities within the Waste Management Activity Program is determined by the types of waste management activities regulated or managed by the participating agencies. In the context of the program, waste is considered to include all forms of organic or inorganic material which may enter water in the designated FREMP study area as a result of man's activities. The FREMP area is the river downstream of Kanaka Creek on the awetted side of the dykes. It is considered that all water within a wider tributary area will eventually pass through the estuary and thereby has the potential for causing a harmful effect. Thus surrounding lakes, streams, rivers, estuarine areas, salt water areas, and groundwater are of concern. The significance of a waste is determined by its potential for causing an environmental impact on the receiving environment. Wastes may include organic sewage, pesticides, storm drainage, industrial waste, sediment loads, special wastes, and other miscellaneous wastes (see glossary for definitions).

Process

The Waste Management Activity Program is responsible to the Management Committee and all recommendations of the working group must be approved by that committee. The designated agency for the activity program, responsible for chairing the working group and delivering the activity program on schedule, is the Surrey office of the Provincial Waste Management Branch. Operational budgets for activity program activities are prepared by its working group for acceptance by the Management Committee Executive. Working group recommendations are implemented by the responsible agencies, which also bear the direct costs. All participating agencies must be prepared to commit necessary staff or other internal resources in order to carry out these recommendations. Budgeted activities are carried out internally or through contract to consultants or suppliers.

Relationships

The Waste Management Activity Program is closely associated with the FREMP Standing Committee on the Fraser River Water Quality Plan. Both programs are intimately involved in the control and management of waste in the Fraser River. The two programs meet at the point where effluent enters the receiving environment. The Waste Management Activity Program is principally involved with waste streams before they enter the receiving environment and the Water Quality Plan is responsible for assessing the effect of the waste once it has been discharged into the receiving environment.

The Waste Management Activity Program is one of nine interrelated activity programs and as such must have good communication with the other groups. This is achieved through the FREMP Management Committee, through coordination by the FREMP Secretariat, and through membership of some working group members on more than one committee.

Public involvement in the activities of the Waste Management Activity Program is obtained through public meetings or by direct input to the Management Committee through the Secretariat as outlined in the Implementation Strategy.

1.2 Objective

The objectives originally established for this activity program in the Implementation Strategy have, to some extent, been met by the participating agencies (Table 1.3). Other activities have come to light which are not reflected in the objectives. For these reasons,

Table 1.3 STATUS OF WASTE MANAGEMENT COMPONENT TASKS ESTABLISHED BY THE IMPLEMENTATION STRATEGY

Component Task	Status
1. Develop a source control program for municipal and industrial effluents.	Municipal source control bylaw being developed under the Greater Vancouver Regional District (GVRD) Liquid Waste Management Plan (LWMP). Industrial source control addressed by permit upgrading, a permit upgrading strategy is recommended in the Activity Plan.
2. Establish criteria for the siting of a hazardous waste disposal and/or collection facility.	Siting criteria for a British Columbia Special Waste Facility have been established by the Special Waste Advisory Committee (SWAC). Siting and program recommendations for handling of household hazardous wastes are part of the LWMP and the Activity Plan. A B.C. Hazardous Waste Corporation was formed June, 1990
3. Develop waste management compliance and upgrading schedules based on attaining and maintaining ambient water quality objectives.	An Enforcement and Compliance Strategy and an Upgrading Strategy are recommended in the Activity Plan. Ambient water quality objectives are addressed by the Standing Committee on the Fraser River Water Quality Plan.
4. Identify present methods and trends in treatment and disposal of liquid and solid wastes and recommend cost-effective means to improve waste treatment and disposal.	These are largely dealt with in the LWMP, the GVRD Solid Waste Management Plan (SWMP), the Agricultural Code of Practice, and various other initiatives identified in Waste Management Activity Program report appendices. Where gaps exist, these are identified and treatment recommended. Discussion of technology is beyond the scope of the Activity Plan.
5. Identify problem spots throughout the estuary by using water quality and biota as indicators and make recommendations to solve the problems.	Also done by the LWMP and the FREMP Water Quality Plan. Some problem spots are identified by the Waste Management Activity Plan but no recommendations are explicitly developed.
6. Other tasks as identified.	Numerous recommendations have been made regarding database management, public awareness, administration, and research directions.

revised objectives have been established which account for present requirements. The principal objective of this program is:

To review issues related to the management and control of discharges of harmful substances to the Fraser Estuary and to make recommendations to member agencies and the management committee for control of these discharges. This is to be achieved through the development and implementation of a Waste Management Activity Program Plan.

The Activity Plan seeks reduction of contaminants from the following sources:

1. **Municipal sewage**
2. **Authorized industrial effluents**
3. **Unregulated waste discharges**
4. **Urban runoff and combined sewer discharges**
5. **Rural runoff and agricultural discharges**
6. **Solid waste disposal**
7. **Groundwater contamination**
8. **Water-based waste disposal**
9. **Illegal dumping of hazardous waste**
10. **Other sources as identified**

The specific tasks which are to be undertaken to achieve this objective have been discussed within relevant appendices, and brought together into a Fraser River Estuary Waste Management Activity Plan.

1.3 References Cited

Fraser River Estuary Management Program Review Committee. 1984. An Implementation Strategy for the Fraser River Estuary Management Program. Victoria: Ministry of Environment. 45p.

Fraser River Estuary Study Planning Committee. 1982. "A Living River by the Door" A Proposed Management Program for the Fraser River Estuary. Surrey: Fraser River Estuary Study. 64p.

Standing Committee on the Fraser River Water Quality Plan. 1988. Water Quality Plan, 1989. Draft. Fraser River Estuary Management Program.

Appendix 2 River Characteristics Affecting Waste Management

Natural river characteristics affect the impact significance of discharge volumes and flows, contaminant concentrations and loadings, discharge timing, and other parameters. Characteristics to be considered when evaluating waste issues, concerns, and management decisions should include the annual river flow regime, tidal influences, and the natural sediment load.

2.1 Flow Regime

Most precipitation in the Fraser River basin falls as snow. Consequently, river flows through the estuary are at a minimum in February and March and rise to a peak during spring freshet in May and June. As recorded at Hope, discharges average 600 - 800 m^3/s in winter and 7000 - 8800 m^3/s in summer. A minimum flow of 340 m^3/s was recorded on January 8, 1916, and a peak flow of 15,200 m^3/s on May 31, 1948. The mean flow is 2700 m^3/s (Benedict et al., 1973; Drinnan and Clark, 1980; DOE, 1983). Drinnan and Clark (1980) and Clark et al. (1981) estimate 10 and 90 percentile monthly flow ranges for the Fraser River at the Pattullo Bridge, including a low of 900 m^3/s in February-March and a freshet maximum of 10,800 m^3/s in May-June (Table 2.1). Water Survey of Canada hydrometric station data summaries (DOE, 1983), where available, show the monthly mean low, average, and high discharges over the period of record, identified in Table 2.1 by a hydrometric station number.

At New Westminster the river bifurcates into two channels. Flow distributions vary with tides and discharge but approximately 15% of the Main Stem flow enters the shallower North Arm and 85% enters the Main Arm. About 6.5% of the Main Arm flow enters Annacis Channel. At Sea Island, about 45% of the North Arm flow is diverted into the Middle Arm. South of Westham Island, Canoe Pass carries 5% of the Main Arm Flow (Figure 2.1). River flushing and dilution effects are therefore greater in the Main Stem and Main Arm than in the North Arm.

Figure 2.1 CHARACTERISTIC FLOW DISTRIBUTIONS IN THE FRASER RIVER SYSTEM

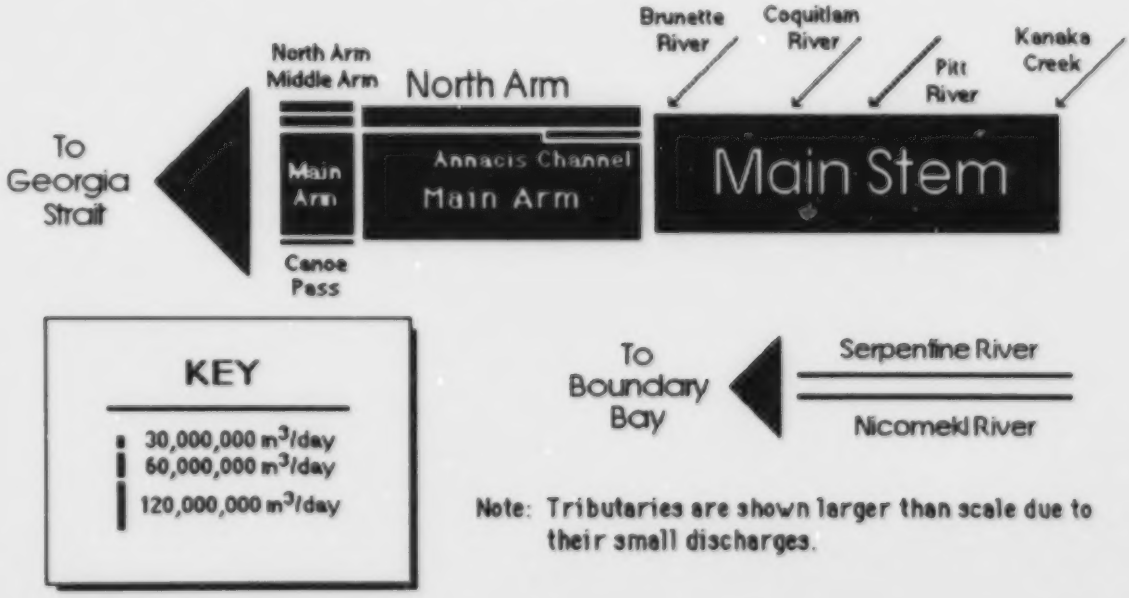


Table 2.1 DISCHARGE VOLUME AND SPEED, FRASER RIVER ESTUARY

Reach (Station Number[2])	Discharge[1] (x 10^6 m^3/day) Low	Average	High	Current Speed[1] (m/s) Low	Average	High
Northern Tributaries:						
Still Creek (08MH061)	0.0104	0.0368	0.0881			
Brunette River (08MH026)	0.0605	0.233	0.518			
Coquitlam River (08MH002)	0.156	0.423	1.054			
Pitt River (08MH017)	1.21	4.67	9.94	0.7	0.5	0.2
				0.7	0.6	0.2
Kanaka Creek (08MH076)	0.044	0.25	0.511			
Fraser River:						
Main Stem	75	294	921			
Port Mann Bridge (08MH126)	153	333	809	1.2	0.5	-
				1.2	1.1	1.4
Pattullo Bridge	78	300	933	0.9	0.2	-
				0.9	0.9	1.5
North Arm	11.7	45	140	1	0.3	-
				0.8	0.8	1.4
Mitchell Island	-	-	-	0.8	0.2	-
				0.9	0.9	1.6
Lower North Arm	6.4	25	77	0.7	0.2	-
				0.9	0.7	1.3
Middle Arm	5.3	20	63	0.6	0.2	0
				0.7	0.6	1.1
Annacis Channel	4.7	18	56			
Annieville Channel	62	237	737	0.9	0.2	-
				0.9	0.9	1.5
Main Arm	66.3	255	793	0.8	0.2	-
				1.1	1	1.8
Canoe Pass	3.3	12.8	40	0.6	0	-
				0.8	0.8	1.3
Main Arm Mouth	63	242	753	1	0.2	-
				1.5	1.2	2.5
Boundary Bay:						
Nicomekl River (08MH050)	0.0344	0.3	0.664			
Serpentine River	Comparable to Nicomekl River					
Campbell River (08MH059)	0.012	0.081	0.211			

[1] High, average, and low river discharge levels are given. The speed of the current for these discharge levels is given for flood (upper) and ebb (lower) conditions.

[2] Environment Canada, Water Survey Branch, hydrographic station number, where used.

2.2 Tidal Influence

The tidal influence varies with river discharge, extending to Chilliwack during low flow periods, but only to Mission during peak discharges (Drinnan and Clark, 1980). River discharges pool during flood tides, an effect which is greatest during low flow periods, with consequent variations in velocity and occasional flow reversal. The ebb flow period lasts roughly twice as long as the flood. Estimated daily maximum current velocities range from 0.5 m/s to over 2 m/s and are greatest near the mouth of the Main Arm (Drinnan and Clark, 1980). A parcel of river water may not flow at slack water, may reverse flow at flood tide, and may receive multiple doses of effluent if an outfall is nearby. River training works also impact river velocity, resulting in faster mid-channel currents, but slower and possibly stagnant near-shore currents behind training walls. Tidal cycles also affect the discharge rate of tributary streams and some effluent outfalls. These flows may pool behind rising river water, with relatively higher loadings of contaminants flushed into the river on the falling ebb cycle. This effect may be exacerbated in low lying areas where flood or storm gates form a physical barrier to tributary flows at high river water levels.

During flood tide a salt wedge moves upstream along the river bottom as far as New Westminster during low flows, but not past Steveston during freshet. This wedge establishes an equilibrium that moves up and down-river on successive tidal cycles. Should a contaminant be dispersed at depth, it could move with the wedge and be distributed throughout the lower estuary (Solisberg, 1987). Wedge penetration also reduces the cross-sectional area of river outflow, increasing surface currents (Drinnan and Clark, 1980). The shallower depth of the North Arm prevents much salt water intrusion. Movement of water over Sturgeon and Roberts Banks is generally east and north-east on a flood tide, and west or south-west on an ebb, though winds also have an influence.

Rates and volumes of river flow are important factors in the dispersion and residence time of contaminants. For example, depending on the time of year and the tidal stage, effluents from the Annacis sewage treatment plant may take between 1 and 3 days to reach the mouth of the Main Arm. The width of the river is a parameter in the initial dilution zone (IDZ) concept defined by the provincial Pollution Control Objectives. An IDZ is based on the premise that receiving water quality objectives will not likely be satisfied in the immediate vicinity of the point of an effluent discharge, otherwise the effluent itself would have to be of receiving water quality. An initial zone of dilution is defined in terms of a downstream and cross-stream distance from the point of discharge, usually 100 m downstream and one-quarter the river width. While the actual volume of river water in which effluent dilutes will vary with the river discharge and velocity, provincial principles for Water Quality Objectives state that acutely toxic conditions, harmful bioconcentration, or other nuisance conditions should not occur in the IDZ. The federal Fisheries Act does not recognize the IDZ concept.

2.3 Sediment Load

The Fraser normally has a high sediment load which peaks during freshet when resuspension and river bed erosion contribute roughly 660,000 tonnes/day of suspended solids (Drinnan and Clark, 1980), a major contribution to the 17,300,000 t/a of sediment carried by the river at Mission (Stewart and Tassone, 1989). This contributes to the normal muddy appearance of the river. Concentrations of dissolved materials in the Fraser are normally low, though these decrease with the discharge volume and increase with the influence of salt water. Fraser River waters are considered "moderately soft" (Drinnan and Clark, 1980), and median pH values are between 7 and 8. The natural buffering capacity of river waters is greater for acid discharges than for alkaline. Dissolved oxygen values in the river are generally close to saturation levels, though lower in the North Arm, and potentially depleted in some stagnant sidewaters or sloughs, especially at depth. Levels of nutrients are typical of low to moderately productive flowing waters; total nitrogen loadings from upstream are estimated to be between 20,000 and 37,000 t/a, phosphate loadings are between 5000 and 9000 t/a, and mean ortho-phosphate loadings are between 300 and 600 t/a. Ninety percent of total copper, 96% of total cadmium, 99% of total iron, and 87% of total zinc are

discharged to the estuary from upstream sources (Drinnan and Clark, 1980; Stancil, 1980), and are generally associated with the freshet sediment loads. However, these and other metals naturally present may not be available for biological uptake or accumulation, nor do they pose an acute threat in most cases.

2.4 References Cited

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Solisberg, L.B. 1987. Spill Response Management Manual: Fraser Port. Environment Canada, Environmental Protection. Fraser River Harbour Commission. 50p.

Stancil, D.E. 1980. Fraser River Estuary Study, Water Quality: Aquatic Biota and Sediments. Victoria: Ministry of Environment. 187p.

Stewart, I. and B. Tassone. 1989. The Fraser Delta: A Review of Historical Sounding Charts. Vancouver: Inland Waters Directorate, Environment Canada.

Appendix 3 Waste Characteristics

Waste discharges to the Fraser River estuary contain numerous pollutants classified as conventional, metal, or organic (Table 3.1). Conventional pollutants include coliform bacteria, non-filterable residue (NFR) or suspended solids, oil and grease, nutrients, and detergents. In addition, water chemistry parameters usually considered in discussions of conventional pollutants include temperature, pH, chemical and biochemical oxygen demand, and dissolved oxygen. These are the pollutants or water quality conditions that have traditionally been dealt with over the history of domestic sewage treatment. Conventional pollutants usually assimilate into the environment, though excessive amounts can cause detrimental impacts.

Metals, other inorganics, and complex organic pollutants such as chlorophenols, dioxins, furans, pesticides, PCBs, and PAHs are a more recent focus of attention and are often referred to as priority or exotic contaminants. Literally hundreds of these chemicals are of special concern due to their knowr. toxicity, high environmental mobility, persistence, and potential for bioaccumulation. Little or nothing is known about thousands more. Some toxic organics, such as PCBs and pesticides, are manufactured, while others, such as the combustion PAHs, have always been present but are greatly increased by human activities. Listings of these chemicals, such as the U.S. EPA list of 126 priority pollutants, or the Canadian Environmental Protection Act (1988) list of toxic substances (Table 3.2), are derived by considering volume of production or use, chemical stability, potential for water contamination, and capability of analytical detection. A number of substances have been selected under CEPA for priority evaluation of their health and environmental impacts (Table 3.3). Regulations may be required for these substances if they are found to be toxic. Some substances for which control options are being developed are not on either toxic or priority substances lists, these include volatile organics and chlorophenates. The Provincial Waste Management Act contains Special Waste Regulations naming wastes which require special disposal procedures (see Appendix 7). Characteristics of these various contaminants are detailed below.

3.1 Conventional Pollutants

a) **Coliform bacteria:**

Pathogenic micro-organisms originating in the digestive tract of animals and humans include bacteria, viruses, protozoa, and fungi. Direct detection of these organisms in receiving waters, while technically feasible, is impractical due to the cost and effort involved. Fecal coliform bacteria are not usually in themselves pathogenic, but are, subject to uncertainties, indicative of the presence of disease-causing bacteria and viruses (Churchland, 1980). Coliforms are also present in soil and plant material, hence the distinction between total and fecal coliforms.

Effluent disinfection, primarily through chlorination, is the most cost-effective method of deactivating coliforms and the associated bacteria and viruses. Chlorine residues may remain after chlorination, however, even when dechlorination is part of the process. During winter months when effluent is not chlorinated, the GVS&DD sewage treatment plants discharge the largest number of coliforms to the Fraser estuary. During summer, principle sources are the sewage treatment plants, combined sewer overflows, stormwater, and upstream sources.

The most common coliform testing technique results in a most probable number (MPN), a high estimate of the actual coliform number. Acceptable fecal coliform counts vary with the water use and tend to be controversial. Criteria accepted in B.C. include 0/100 ml for drinking water, 14/100 ml for shellfish harvesting, 200/100 ml for swimming and other

water contact recreation, 1000/100 ml for irrigation and non-water contact recreation, and 2000/100 ml for all other waters.

b) **Detergents:**

Detergents include surfactants, methylene blue active substances (MBAS), and foaming agents. Generally biodegradable, impacts are primarily aesthetic ones of a surface foam or scum, though Higgs (1977) found that detergents contributed to acute toxicity of STP effluent. Household cleaning agents are a main source of detergents to sewage. Other sources include car or truck wash waters draining into storm sewers and sanitary cross connections to storm sewers.

c) **Non-Filterable Residue (NFR):**

NFR is suspended solids that tend to settle out under low- or no-flow conditions, and are not passable through filters. The suspended solid load of the Fraser River is already high, but anthropogenic NFR loadings increase this by 3 - 5%, and impacts cannot be ruled out (Stancil, 1980). The suspended particles of silt and other mineral-like materials contributed by wastewater to the Fraser estuary may be unlike those of natural sources. NFR impacts include reduction of light transmission, transportation of adhered contaminants, and clogging of respiratory, feeding, and digestive systems of aquatic organisms. Over time, increased sediment loading can result in changes to biological habitat and community structure. Other contaminants, particularly metals, bind to sediment particles and sedimentation acts as a contaminant sink.

Primary sources of NFR loadings, other than the upstream vector, are the sewage treatment plants and stormwater runoff. Other sources are industrial effluents, landfill leachates, and combined sewer overflows. Color, a measure of dissolved coloring compounds such as iron, manganese, tannins, or lignins, also affects light transmission. Sources of color include the forest industry (Stancil, 1980).

d) **Nutrients:**

Nutrients include nitrogen, phosphorus, and carbon which are necessary to support primary producers and decomposers. Bacterial growth is also dependant on the amount of nutrients. Excessive nutrients can lead to overproduction of organisms, including algal blooms. Subsequent algal die-off can depress dissolved oxygen levels, impact aesthetic qualities, and interfere with water use by man or other organisms. Some forms of nutrients exhibit acute toxicity to biota at elevated levels. Common measures of nutrients are Kjeldahl nitrogen, nitrate/nitrite, ammonia, total phosphorus, and total organic and inorganic carbon.

The sewage treatment plants are the most significant source of wastewater nitrogen and phosphorus to the estuary, with some contribution from stormwater and combined sewer overflows. Industrial effluents and landfills contribute small quantities, and agricultural sources are especially significant in some areas.

e) **Oil and Grease:**

Oil and grease is a measure of hydrocarbon contamination. Principle constituents are vegetable oils, animal oils and fats, and petroleum and mineral based materials including high flashpoint derivatives such as gasoline. Petroleum based compounds are generally toxic, while non-petroleum oils are not. Detrimental impacts on the receiving environment include toxicity, the formation of surface films which limit oxygen transfer, increased oxygen demand, and death of waterfowl from loss of buoyancy or insulating capacity. Primary sources of oil and grease are stormwater discharges, STP effluents, and industrial effluents. Water-based sources of of oil and grease such as shipping or spills could impact localized shoreline areas.

f) **Oxygen Demanding Substances:**

Chemical oxygen demand (COD) is exerted by organic or inorganic chemicals, organic materials such as decaying plant and animal matter, or other materials in effluent that enter receiving waters in a reduced state and consume oxygen as they become oxidized. Biochemical oxygen demand (BOD) is the demand for oxygen placed on receiving waters by aerobic microbiota in effluents, or by microbiotic populations that increase as a result of effluent discharges. BOD5 is a test used to measure the five day oxygen demand of microbiota.

While oxygen demand may decrease or deplete oxygen levels, dissolved oxygen is a measure of the amount of oxygen present. Concentration is an absolute measure of the oxygen present, while percent saturation is a relative measure as the solubility of oxygen varies inversely with temperature and salinity.

Main sources of oxygen demand loadings to the Fraser estuary are the sewage treatment plants, stormwater discharges, combined sewer overflows, and industrial effluents, particularly from fish processing plants (Stancil, 1980). Other sources include leachates from woodwaste dumps and other landfills, rural runoff from humus soils, and agricultural waste discharges. Unauthorized and accidental discharges occasionally have produced fish kills through oxygen depletion.

g) **pH:**

Normal pH values in the receiving waters of the Fraser estuary range from 7 to 8. Acidic discharges can lower these values leading to impacts on phytoplankton species number and biomass, juvenile salmonid mortality, and solubility of other contaminants. Discharges with pH lower than normal river levels are from STPs, the forest and metal finishing industries, stormwater runoff, rural runoff from peat bogs, and landfill leachates. Normal coastal rainfall pH is about 5.3, the average in the region is in the mildly acidic range 4.5 - 5.0 (MOE, 1985).

Alkaline discharges can increase pH values to above 9 where adverse impacts on biota may occur. Sources of alkaline effluents are concrete batch plants, forest industries, and metal finishing industries.

h) **Temperature:**

Both temperature range and fluctuation determine the composition of a biological community. Organisms have a favored temperature range, and varying tolerance to fluctuations within or outside this range. Impacts can arise from temperature discrepancies between discharges and receiving waters. While most effluent discharges have a higher temperature than receiving waters, discharges of particular concern are industrial coolant and process waters.

3.2 Metals

a) **Metals and other inorganics:**

The metallic elements may appear as metals, ions, or inorganic forms such as salts, sulfides, or oxides. Dissolved and particulate forms vary in abundance and availability to biota. Metals vary in concentration and toxicity and are of concern because they are persistent, may bioaccumulate, and can be toxic. The GVRD Combined Sewer Overflow and Urban Runoff Committee determined that arsenic, cadmium, chromium, copper, lead, and zinc were of most interest to the LWMP (GVRD, 1988).

Sources of metals are riverbed scour, loads from upstream, sewage treatment plants, stormwater, combined sewer overflows, industrial effluents, and leachates. The sewage treatment plants contribute major loadings of iron and lead, and pass through copper and zinc from municipal water supply pipes. Industry contributes a large proportion of zinc, and also has an impact of varying proportions depending on influent loads to the three STPs. The following metals discussion is largely drawn from Jordon and Carley (1989).

Aluminum is used princially for aluminum products and paints. It is widely distributed in the environment and is relatively non-toxic, though linked to brain disease and behavioral problems.

Arsenic is primarily used in pesticides, wood preservatives, alloy additives, and solder production. It is toxic to varying degrees to fish, lower forms of aquatic animals and plants, and bacteria. It inhibits biological treatment processes at relatively low thresholds, and is a potential carcinogen.

Cadmium is used primarily in electroplating and battery production. It is toxic at low concentrations to fish, aquatic organisms, and humans.

Cobalt is used in the production of alloys for cutting and wear resistant materials, steels, welding materials, and permanent magnets. Minor uses include paints, pigments, inks, and glass. It is relatively non-toxic, though it may cause skin hypersensitivity or dermatitis.

Copper is used for plumbing, electrical wiring, electroplating, alloys, and pesticides. It is not especially toxic to humans, but is fairly toxic to various species of fish and saltwater animals.

Iron is used mainly for steel products. It is essentially non-toxic and is an important trace metal for most life forms.

Lead is used principally in batteries, solder, and as a gasoline additive. It is highly toxic, and bioaccumulative, with an affinity for bone tissue. It is embroyotonic, teratogenic, and carcinogenic, though there is no evidence of carcinogenic effects in humans.

Manganese is used mainly in alloys ans as a chemical salt. It is relatively non-toxic and an important micro-nutrient, but problems are associated with abnormally high concentrations. It may bioaccumulate in molluscs.

Mercury is used in the productionof fungicides and plastics. It is highly toxic, bioaccumulates, and is a potent teratogen.

Molybdenum is used primarily in alloys and paints. It is relatively non-toxic and does not accumulate, but its role in body chemistry is poorly understood.

Nickel is used for batteries, alloys, and electroplating. It is relatively toxic to aquatic organisms, but less so to humans. It is a teratogenic, and a carcinogenic when inhaled.

Silver is used for photographic film, housewares, jewelery, electrical contacts, catalysts, mirrors, coinage, and dental/medical applications. Not especially toxic to humans, it is more toxic to aquatic organisms.

Zinc is used mainly for galvanizing and electoplating. Zinc is also contributed from the wearing of rubber road tires. An essential element, it tends to be less toxic than most other heavy metals, though large doses may be carcinogenic.

b) **Ammoniacal and Chromated Copper Arsenate (ACA, CCA):**

These metal-based compounds are used by the forest industry as alternatives to chlorophenol wood protection fungicides. Alternatives may be as toxic, and environmental effects are still being investigated.

c) **Copper-8-quinolinoate:**

NYTEK, an acid solution, or PQ-8, an alkaline solution of solid particles, are used as wood protection agents. These solutions have half the toxicity of chlorophenols or TCMTB.

3.3 Organics

a) **Chlorophenols:**

Phenolics are acid extractable monocyclic aromatic hydrocarbons. Collectively, they may remain in the water column or accumulate in sediments, some bioaccumulate in aquatic biota. Chlorophenols are phenolics with chlorine atoms attached. The toxic forms are those with 3, 4, or 5 chlorine atoms: trichlorophenol (TCP), tetrachlorophenol (TTCP), and pentachorophenol (PCP). Chlorophenols are used as pesticides to control sap and blue stain fungi that attack cut wood, and are leached from treated wood stored at forest product yards or port loading facilities. These compounds are extremely toxic at concentrations as low as 32 parts per billion. Salmon fry placed in a concentration equivalent to one drop of pure chemical in 360 barrels of water show immediate signs of distress with death following within two hours (Krahn et al., 1987). Chlorophenol use in the estuary has largely been phased out in favor of TCMTB or other wood protection agents.

b) **Dioxins and Furans:**

Polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzo-p-difurans (PCDF) are commonly known as dioxins and furans respectively. They are two benzene rings attached together with one (furans) or with two (dioxins) oxygens, the number of chlorines also attached to the molecule distinguishes the 75 dioxins and 135 furans. These are extremely toxic substances; the dioxin 2,3,7,8 tetrachloro-dibenzo-p-dioxin (2,3,7,8 TCDD) is one of the most toxic substances known, less than one-millionth of a gram will kill a guinea pig (Keating, 1986). Dioxins and furans are often associated with other chlorinated compounds, including pesticides and PCBs, as impurities introduced during the manufacturing process. They may be introduced as byproducts during chlorine bleaching processes in pulp mills, or by individual processes in petroleum refineries. They are also found in refuse incineration plant (RIP) emissions; smoke from forest fires, slash, or wood fuel; and combustion of auto fuels.

c) **Pesticides:**

Pesticides are substances intended to repel, kill, prevent, or regulate the growth of target biological organisms. Included are herbicides, insecticides, fungicides, rodenticides, nematicides, fumigants, disinfectants, and repellants. Wood preservatives and antifoulants, considered separately in this section, are also pesticides. Pesticides usually consist of an active and inert ingredient mixture. The active ingredient is intended to act on the target pest, but any ingredients may be toxic to nontarget species. Many pesticide active ingredients belong to three major classes: organochlorines, organophosphates, and carbimates. Organochlorines tend to be persistent and bioaccumulative, and many are either no longer used in the Fraser estuary tributary area or are strictly controlled. These include the DDTs, acrolein, chlordane, dieldrin, heptachlor, and toxaphene. Most organophosphates and carbamates have limited persistence and are water soluble so tend not to bioaccumulate. They may be more toxic than organochlorines, however, due to their effect on nervous system enzymes. Common organophosphate pesticides used in the lower mainland include captan,

diazinon, malathion, methyl parathion, parathion, and phorate. Other pesticides commonly used in lower mainland residential areas are 2,4-D, dicamba, mecoprop, and methoxychlor, which are nonpersistent. While the GVRD LWMP considers that pesticides are not a significant contaminant in the region (GVRD, 1988a), ecological concerns are also related to chronic toxicity, of which less data exist than for acute toxicity on which the GVRD assessment is based. Monitoring studies have tended to focus on pesticides now out of common use, little data are available regarding the environmental fate and concentration of contemporary pesticides.

d) **Phthalate Esters:**

Phthalate esters are plasticizers, used in plastic bags and packaging. They are ubiquitous and persistant in the environment. Main sources are landfill leachates and sewage treatment plant effluents. Phthalate esters detected in sewage effluent include (Swain and Holms, 1985):

butyl benzyl	dimethyl
di-n-butyl	di-n-octyl
diethyl	bis-(2-ethylhexyl)

e) **Polychlorinated Biphenyls (PCBs):**

PCBs are a member of the family of chlorinated hydrocarbons, in this case containing up to 10 chlorine atoms attached to a biphenyl molecule to give 209 possible PCB compounds. They can be liquids or solids, depending on the number of chlorine atoms, are very stable, noncorrosive, nonflammable, insoluble in water, soluble in fuel oils, and, at ambient temperatures, have low vapor pressure (DOE, 1988). They are resistant to decomposition and have excellent insulation properties, consequently receiving wide use as dielectric fluids in electrical transformers and other electrical equipment. This resistance to decomposition is a factor in their environmental persistence as they do not readily biodegrade. PCBs have extreme environmental mobility, migrate widely, and are soluble in oils and the fatty tissues of animals where they bioaccumulate. They were never manufactured in Canada, and were mainly imported from the United States in the pure form or as askarel. Askarel is a generic term used for PCBs mixed with chlorinated benzenes. Production and new uses are now banned in Canada and the U.S. In Canada, PCBs are controlled through the Canadian Environmental Protection Act (1988). PCBs may enter the environment from landfill leachates, from incomplete combustion, or from leaks, spills, and illegal dumping. Half of all PCBs produced have been discarded in landfills (DOE, 1988). According to the Canadian Council of Environment Ministers (CCEM), the preferred way to disposing of PCBs is through incineration, but a temperature of 1200° C is required. In B.C., PCBs are a special waste and their storage and transport is regulated (Appendix 7).

f) **Polycyclic Aromatic Hydrocarbons (PAHs):**

The polycyclic (or polynuclear) aromatic hydrocarbons are a class of complex organic compounds consisting of aromatic (benzene) rings that share a pair of carbon atoms. The simplest PAH is naphthlate which is two joined benzene rings. Anthracene and phenanthrene each have three rings. They are persistant and ubiquitous combustion byproducts from cars, cigarettes, barbecues, and and natural events such as forest fires. They are distributed through atmospheric deposition and runoff. They are also present in creosote and other wood protection chemicals, where they may be leached into receiving waters. Stormwater, petroleum spills, oil refinery effluents, and refinery wastes in STP effluents are also sources of PAHs. High PAH levels in sediments have been indicted in incidences of tumors and liver lesions in bottom dwelling fish. Sixteen PAHs have been generally looked for in Fraser estuary effluent monitoring (Swain and Holms, 1985):

acenaphthene	benzo(ghi) perylene	fluorene
acenaphthylene	benzo(a) pyrene	ideno(1,2,3-cd) pyrene
anthracene	chrysene	naphthalene
benzo(a) anthracene	dibenzo(ah) anthracene	phenanthrene
benzo(b) fluoranthene	fluoranthene	pyrene
benzo(k) fluoranthene		

g) 2-(thiocyanomethylthio)-benzothiazole (TCMTB):

An alternative to chlorophenol use as a wood preservative, TCMTBs are as toxic but degrade more readily in the environment. They are applied to wood as a diluted solution containing 0.4 - 1.2% active ingredient. Environmental effects and impacts are still being investigated. They are not naturally occurring , but are present in the environment via spills and stormwater runoff.

h) **Tributyl tin (TBT) and other organotins:**

An extremely toxic pesticide, TBTs are used in anti-fouling paints to stop the growth of algae and other marine life. The paints are formulated to allow the slow release of TBTs, contaminating waters near marinas and small craft harbors. Some evidence suggests TBTs are bioconcentrated. Tributlytin and its metabolite di-n-butlytin have been detected in the flesh of Alaskan pen reared salmon. Little is known of the environmental impact of TBTs in the Fraser River estuary.

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Table 3.1 SUMMARY OF POLLUTANTS

CONVENTIONAL

- Coliforms
- Detergents
- Oil and Grease
- Oxygen demanding substances:
  - BOD5
  - COD
- Nutrients:
  - Ammonia
  - Nitrate
  - Nitrite
  - Phosphorus
  - Total organic carbon (TOC)
- Total inorganic carbon (TIC)
- Suspended Solids (NFR)
- Boron
- Chloride
- Chlorine residues
- Cyanide
- Sulphate
- pH
- Temperature

METALS

- Aluminum
- Arsenic
- Barium
- Cadmium
- Chromium
- Cobalt
- Copper
- Iron
- Lead
- Magnesium
- Manganese
- Mercury
- Molybdenum
- Nickel
- Selenium
- Silver
- Tin
- Vanadium
- Zinc

- Ammoniacal copper arsenate (ACA)
- Chromated copper arsenate (CCA)
- Copper-8-quinolinoate

ORGANIC

- Phenols
- Chlorophenols:
  - Trichlorophenol (TCP)
  - Tetrachlorophenol (TTCP)
  - Pentachlorophenol (PCP)
- PCBs:
  - Askarel (PCB + chlorinated benzenes)
  - Aroclor, Inerteen, Pyranol } Common askarels
- Dioxins and Furans
- Tributyltin (TBT)
- TCMTB
- Benzene
- Toluene
- Phthalate esters
- Polycyclic aromatic hydrocarbons (PAHs)
  - acenaphthene, acenaphthylene, anthracene, chrysene, fluoranthene, fluorene, naphthalene, perylene, phenanthrene, pyrene
- Pesticides:
  - Organochlorines:
    - acrolein; aldrin; chlordane; DDT; disofol; dieldrin; endosulfan; endrin; heptachlor; hexachlorocyclohexanes (inc. lindane); methoxychlor; mirex
  - Organophosphates:
    - chloropyrifos; diazinon; disulfotor; malathion; methamidophos; methyl parathion; parathion; phorate
  - Carbimates:
    - aldicarb; bendiocarb; butylate; carbaryl; carbofuran; methomyl; vernolate
  - Anilides:
    - alachlor
  - Benzoic acids:
    - dicamba
  - Nitroanilines:
    - trifluralin
  - Phenols:
    - dinoseb
  - Phenoxyaliphatic acids:
    - 2,4-D; 2,4,5-T
  - Pyrethrins:
    - fenvalerate
  - Pyridine-carboxylic acids:
    - triclopyr
  - Triazines:
    - atrazine; prometon; simazine; toxaphene
  - Uracils:
    - bromacil; tebuthiuron; terbacil
- Woodwaste leachates

Note: Many substances not listed here, especially organics, are also found in the estuary.

Table 3.2 CEPA LIST OF TOXIC SUBSTANCES

	Name or Description of Substance	Type of Regulation Applicable
1.	Chlorobiphenyls that have the molecular formula $C_{12}H_{10-n}Cl_n$ in which "n" is greater than 2 (PCBs)	(a) Prohibited commercial, manufacturing, or processing uses (b) Maximum concentrations in products (c) Maximum quantities and concentrations that may be released into the environment
2.	Dodecachloropentacyclo-[5.3.0.0^{2,6}.0^{3,9}.0^{4,8}]decane	Prohibited commercial, manufacturing, or processing uses
3.	Polybrominated biphenyls that have the formula $C_{12}H_{10-n}Br_n$ in which "n" is greater than 2	Prohibited commercial, manufacturing, or processing uses
4.	Chlorofluorocarbon: totally halogenated chloroflurocarbons that have the molecular formula $C_nCl_xF_{(2n+2-x)}$	Prohibited commercial, manufacturing, or processing uses
5.	Polychlorinated terphenyls that have a molecular formula $C_{18}H_{14-n}Cl_n$ in which "n" is greater than 2	Prohibited commercial, manufacturing, or processing uses
6.	Asbestos	Limited atmospheric releases from asbestos mines and mills
7.	Lead	Limited atmospheric releases from lead smelters
8.	Mercury	Limited atmospheric releases from chlor-alkali mercury plants
9.	Vinyl Chloride	Limited atmospheric releases from vinyl chloride and polyvinyl chloride plants

(Source: Canadian Environmental Protection Act (1988) Schedule I)

Table 3.3 CEPA PRIORITY SUBSTANCES LIST

As required by CEPA Sec 12(1), the following substances will be assessed for toxic characteristics according to the definition given in Section 11 of the Act. Regulations may be recommended following the assessment. Assessment reports for substances in Groups 1, 2, and 3 are planned for completion within three, four, and five years, respectively.

Group 1	Group 2
Arsenic and its compounds	Cadmium and its compounds
Benzene	Chlorinated wastewater effluents
Effluents from pulp mills using bleaching	Chlorobenzene
Hexachlorobenzene	Chromium and its compounds
Methyl tertiary-butyl ether	Creosote-impregnated waste materials
Polychlorinated dibenzodioxins	Dibutyl phthalate
Polychlorinated dibenzofurans	1,2-Dichlorobenzene
Polycyclic aromatic hydrocarbons	1,4-Dichlorobenzene
Waste crankcase oils	1,2-Dichloroethane
	Dichloromethane
	Di-n-octyl phthalate
Group 3	bis(2-ethylhexyl) phthalate
	Inorganic fluorides
Aniline	Nickel and its compounds
Benzidine	Pentachlorobenzene
Chlorinated paraffin waxes	Styrene
bis(2-Chloroethyl) ether	Tetrachlorobenzenes
bis(Chloromethyl) ether	1,1,2,2-Tetrachloroethane
Chloromethyl methyl ether	Tetrachloroethylene
3,3'-Dichlorobenzidine	Toluene
3,5-Dimethylaniline	Trichlorobenzenes
Methyl methacrylate	1,1,1-Trichloroethane
Mineral fibres	Trichloroethylene
Organotin compounds (non-pesticidal uses)	Xylenes

(Source: Canada Gazette, February 11, 1989)

Table 3.4 SOURCES AND EFFECTS OF SOME FRASER ESTUARY POLLUTANTS

Pollutant	Source	Effect
BOD5 COD	STPs Industrial Effluents Stormwater CSOs Agricultural	Depleted oxygen levels
Coliforms	STPs CSOs Stormwater	Indicate presence of disease-causing bacteria and viruses
Detergents	STPs Industrial effluents Stormwater	Foaming and scum Toxicity
NFR	STPs Stormwater	Reduced light transmission Transport of particulates Clogging of aquatic organism respiratory, and digestive systems Deposition of sediment load
Nutrients	STPs CSOs Stormwater Agricultural	Overproduction of organisms Potential depleted oxygen Impaired aesthetics Toxicity
Oil and grease	STPs Industrial Effluents Stormwater	Surface films limit oxygen transfer Toxicity
pH	STPs Industrial Effluents Stormwater Groundwater	Affects solubility of other contaminants Toxicity
Temperature	Industrial Effluents	Biological impacts
Metals	STPs Industrial Effluents Stormwater CSOs Leachates	Toxicity Tainting of fish
ACAs, CCAs	Industrial Effluents Stormwater	Toxicity Tainting of fish
Chlorophenols	Industrial Effluents Stormwater	Toxicity Tainting of fish
Dioxins and Furans	Industrial Effluents Stormwater	Toxicity Tainting of fish
Pesticides	Stormwater Agricultural	Toxicity Tainting of fish
PCBs	Groundwater Spills	Toxicity Tainting of fish
PAHs	Stormwater Industrial Effluents	Toxicity Tainting of fish
TCMTB	Industrial Effluents Stormwater	Toxicity Tainting of fish
TBTs (Organotins)	Leachates Water-contact structures	Toxicity Tainting of fish

Appendix 4 Information and Monitoring

Monitoring of water column, sediment, and biota is necessary as an indication of the magnitude of impact and of what needs to be done in effluent control. Analysis of monitoring data identifies the contaminants of concern, the areas of higher concentration, and the areas of synergistic or additive affects for which remedial actions are required. These physical, chemical, biological, and pollutant discharge data are used to determine or evaluate changes, trends, and specific problem areas regarding contaminants or water quality of the Fraser estuary. A number of agencies collect data or monitor conditions in the estuary on either a short or long term basis. Efforts directed towards evaluating water quality and waste management in the Fraser estuary received new impetus in the early 1970s and are continuing. Earlier data is dated due to changes in monitoring techniques and lower detection limits. These programs are described below as an overview of monitoring and information collection activities.

4.1 Department of the Environment

An extensive wastewater sampling program was carried out through the Environmental Protection Service of Environment Canada in 1973 (Tanner et al., 1973). In addition, the first in a Special Estuary Series outlining the status of knowledge for various British Columbia estuaries covered waste disposal and pollution problems for the Fraser estuary (Hoos and Packman, 1974). These data are dated. Continued EP initiatives within the estuary include chlorophenol monitoring (Krahn et al., 1987), monitoring of priority compounds, monitoring of other contaminants of concern, and monitoring of the outer estuary (Harding et al., 1988). The Inland Waters Directorate also monitors water quality as special projects, and as part of the Water Survey of Canada hydrologic station network.

4.2 Westwater Research Centre, University of British Columbia

The Westwater Research Centre Water Quality Management Program, in turn part of a much larger program on the biological, physical, and socio-economic aspects of the lower Fraser River, was conducted during the 1970s at the University of British Columbia. Topics covered included baseline surveys (Bawden et al., 1973), water quality surveys (Benedict et al., 1973; Hall et al., 1974), contaminant concentrations in the receiving environment (Northcote et al., 1975), and contaminant constituents in discharges (Koch et al., 1977; Koch and Hall, 1981). Studies were summarized in a series of public lectures (Dorcey, 1976). Monitoring has continued for chlorophenols, leachates, and toxicity (Hall and Anderson, 1988).

4.3 Fraser River Estuary Study Program

As part of the Fraser River Estuary Study (FRES) Phase 1 program established in 1977, the Water Quality Working Group produced 16 background and ancillary reports ranging from analysis of data collected during 1970-1978 for water chemistry (Drinnan and Clark, 1980), municipal effluents (Cain and Swain, 1980), industrial effluents (Swain, 1980), water quality (Churchland, 1980; Garrett, 1980), and discharge composition (Cain et al., 1980; Singleton, 1980), to more general analyses of stormwater (Ferguson and Hall, 1979), landfills (Atwater, 1980), aquatic biota and sediments (Stancil, 1980), and Boundary Bay (Swain and Alexander, 1981). A summary report was also published with conclusions and recommendations (FRES Steering Committee, 1979). While somewhat dated, these data summaries are still used where nothing else is available.

4.4 Standing Committee on the Fraser River Estuary Water Quality Plan

The FREMP Standing Committee on the Fraser River Estuary Water Quality Plan was established in May 1986 to develop acceptable intergovernmental ambient water quality objectives, coordinate monitoring programs, and document acceptable enforcement arrangements (Standing Committee, 1988a). A major initiative is the production of a Water

Quality Plan for the Fraser Estuary. This plan has recommendations for a three-year cycle monitoring program coordinated through the FREMP office, and suggestions for data management, interpretation, and prioritization of general and specific special studies. Also considered is the necessity for agreed-upon Federal/Provincial revisions to water quality objectives. The Standing Committee produces a triennial Status Report on Water Quality, and sponsors an annual Fraser River Estuary Workshop on Monitoring and Research. Proceedings from the workshop are published with an annual summary of monitoring and research activities (Standing Committee, 1987a; 1987b; 1988a; 1988b; 1989). The Waste Management Activity Program coordinates with the Water Quality Plan by providing recommendations for effluent monitoring, and through waste management activities designed to address water quality concerns identified by the Standing Committee.

4.5 Fraser River Harbour Commission and Ministry of Environment

Phase 2 of the Fraser River Estuary Study recognized the need to develop an integrated water quality and waste management monitoring program. In March 1982 a monitoring committee was formed, and recommended a program (Working Committee on Fraser River Estuary Monitoring, 1984). The recommended 5-year program was implemented under the auspices of the Fraser River Harbour Commission in 1986 with funding and other assistance from the Ministry of Environment. First-year monitoring covered effluent (Supervisory Coordinating Committee, 1987), continued in 1987 with benthos and sediment monitoring (Swain and Walton, 1988), and in 1988-89 with monitoring of biota (Swain and Walton, 1989). The focus of the program for 1989-90 is a detailed examination of Boundary Bay sediments, invertebrates, and fish.

4.6 MOE, Water Quality Objectives

Water Quality Objectives for site specific fresh, estuarine, and coastal marine surface water bodies are being developed under the mandate derived from the Environmental Management Act to manage water quality in the province. Provisional water quality assessments and objectives for the lower Fraser River (Swain and Holms, 1985a; 1985b), Boundary Bay (Swain and Holms, 1988), and the tributaries entering the Fraser River Main Stem along the north shore (Swain, In Prep.) have been established. Objectives for the Harrison Lillooet area are in preparation (Swain, In Prep.). These objectives are not enforceable under any federal or provincial legislation, however, they do serve as the basis for establishing waste discharge concentrations along with the Pollution Control Objectives. They are intended to establish a baseline for protection of water quality for the most sensitive use at a particular site (MOE, 1986). They are based on water quality criteria, such as those developed by the Canada Council of Resource and Environment Ministers (CCREM, 1987), which are scientific guidelines relating the physical, chemical, or biological characteristics of water, biota, or sediment to their effects on water use, including aquatic life. The Ministry of Environment, Water Management Branch has published criteria for a variety of parameters. Objectives are derived from criteria by considering the local water quality, water uses, water movement, waste discharges, and socio-economic factors. Designated water uses are made in order to protect water supplies for drinking, public water supply, and food processing; aquatic life and wildlife; agriculture; recreation and aesthetics; and industrial uses. Sampling programs monitor attainment of objectives and results are reported annually (Rocchini, 1987; 1988; MOE, 1989). Objectives are not intended to be used for back calculating effluent discharge quality.

4.7 Greater Vancouver Regional District

Most of the Fraser estuary is within the Greater Vancouver Regional District, though GVRD boundaries also include Burrard Inlet. Regional waste management concerns have been broadly addressed in the past in the Lea Report of 1913, the Rawn Report of 1953, and the Rawn update of 1970. A Solid Waste Management Plan was adopted in 1985 (GVS&DD, 1985).

Currently, a Liquid Waste Management Plan (LWMP) (GVRD, 1988a) is being prepared under authority of the B.C. Waste Management Act (1982). Under this act, a municipality or regional district may discharge waste in accordance with an approved plan which would replace existing pollution control permits and approvals. In process for two years, the LWMP Stage 1 consists of the collection of existing information, the examination of existing conditions, the development of waste management alternatives in conceptual form, and the presentation of a set of realistic waste management options. Four technical committees have reported on urban runoff and combined sewer overflows (GVRD, 1988b), sewage treatment plant upgrading/sludge disposal (GVRD, 1988c), source control (GVRD, 1988d), and water quality/water use (GVRD, 1988e). These reports are collated into a summary Stage 1 Plan written by the GVS&DD which incorporated some but not all of the advice of the committees. These reports collectively comprise the most comprehensive recent overview of waste management concerns for the Fraser estuary, only direct industrial sector discharges and miscellaneous wastes are not covered in much detail. As part of the process, ambient water quality conditions were reported by Coastline Environmental Consultants Ltd (1987).

As part of their routine permit monitoring, the GVRD monitors conventional, inorganic, and organic contaminants, and conducts bioassays at the GVS&DD Iona Island, Annacis Island, and Lulu Island sewage treatment plants. Coliform monitoring at bathing beaches is performed by the GVRD in conjunction with the Ministry of Health. A major monitoring program is ongoing for the Iona deep sea outfall. Commencing in January 1986, two years of baseline monitoring were conducted before the outfall began operation in April 1988. The two-year predischarge program concentrated on the effluent-water-sediment-biota pathway. The 1989 program includes studies of the predischarge data, characterization of effluent and sediments, bacteriological water quality, infaunal community health, and biota pathology.

4.8 Other Programs

Other data collection and/or monitoring programs which are underway include Waste Management Branch monitoring of permitted discharges. Special project data collection on various aspects of waste management is implemented through Environmental Protection and Inland Waters and Lands of Environment Canada, Water Management and Waste Management Branches of the B.C. Ministry of Environment, various municipal and regional district departments, and private consultants under contract to the aforementioned agencies. Notable efforts include chlorophenol monitoring. These are referenced where relevant in the appendices that follow.

4.9 Status of Knowledge and Data Gaps

As a consequence of these data collection efforts, fairly good information exists for receiving water conditions, sewage treatment plant effluents, and some industrial effluents. However, data are not as comprehensive for stormwater discharges, agricultural wastewaters, combined sewer overflows, leachates, groundwaters, sediments, upstream contaminants (except for coliforms and some metals), atmospheric deposition, and special wastes. Other problems include availability or accessibility of data, consistency of data collection, reporting, or publishing of reports, use of different sampling or testing methods, and the amount of analysis and interpretation performed. These problems can impair the utility of data that do exist. A federal/provincial monitoring station maintained at Hope gives some idea of the quality of Fraser River water entering the Lower Fraser Basin, but quality is affected by tributary flows between Hope and Kanaka Creek. The Standing Committee on the Fraser River Water Quality Plan (1988a) recommends establishing a monitoring station near Mission.

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Appendix 5 Legislative Mandate

5.1 Introduction

The federal, provincial, and municipal governments are responsible for several key pieces of legislation which control or prevent the discharge of pollutants to the estuary. These have been described by various authors (Harding et al., 1987; Standing Committee, 1988). The following discussion presents this legislative basis from the perspective of controlling pollution at the source rather than from the perspective of protecting the receiving environment once pollutants have been discharged. The discussion is therefore somewhat restricted from the point of view of habitat protection. A more comprehensive treatment of this aspect has been given by the former authors.

Jurisdictional authority between the federal and provincial levels of government was established under the British North America Act 1867. This statute of the Parliament of Great Britain has been replaced by the Constitution Act which was enacted by the Parliament of Canada in 1982. The role of the federal government in environmental matters was established in the BNA Act and confirmed in the Constitution Act particularly under the broad category of matters of national concern under the "peace, order and good government" head of power. This authority extends to management of fisheries, migratory birds, navigation, and shipping. The division of power among federal and provincial laws has led to overlapping jurisdiction in many areas of environmental management. This in turn has led to cooperative management through protocol agreements, memos of understanding, and federal-provincial accords. However, there are some clear lines of responsibility for both levels of government. The combination of clearly defined and overlapping jurisdiction has led to a complex network of administrative processes, policies, and procedures. The legislative basis for managing or preventing the release of pollutants and for carrying out this cooperative management in the Fraser Estuary is described below.

5.2 Federal Legislation

The federal government administers several pieces of legislation which address the release of pollutants to the environment or which control the handling and disposal of deleterious substances.

Canadian Environmental Protection Act

The Canadian Environmental Protection Act (CEPA) was assented to June 28, 1988. It supersedes the Clean Air Act, the Environmental Contaminants Act, the Ocean Dumping Control Act, and Part III of the Canada Water Act. The act is designed to deal with all aspects of the life cycle of chemicals, not just release to the environment. It gives broader powers to regulate toxic substances which are listed as "priority chemicals" within the act. The sections of the act which are of most importance to industry are the provisions concerning prohibited and restricted substances, substances requiring export or import notification, and requirements concerning the response to toxic spills. The act provides for inspection of any place where there are reasonable grounds to believe that the act has been contravened, and sets down stringent penalties. The act deals with ocean dumping as well as emissions to land and air.

At present, most actions taken under this act are being implemented through the original pieces of legislation rather than CEPA. Discussions are being held between the provincial and federal governments in matters dealing with equivalency of requirements so that provincial requirements can be employed where equivalent standards are required under provincial statutes. Part 6 of CEPA supersedes the Ocean Dumping Control Act and controls the dumping of wastes and other substances into the ocean or the sea as defined.

Dumping is prohibited except under the terms of a permit, a board of review is created to review permit applications, and offences and punishments are provided for. Regulations set out the areas where the act is in force and list prohibited and restricted substances. The other acts which CEPA replaces are discussed below since they still form the basis for enforcement action under CEPA.

Clean Air Act

The Clean Air Act regulates ambient air quality and the control of air pollution. Administered by Environment Canada, it provides for the collection of data; research into the nature, transportation, dispersion, effects, controls, and abatement of air pollutants; the dissemination of information; the establishment of national ambient air quality objectives; and inter-government cooperation.

Environmental Contaminants Act

The Environmental Contaminants Act regulates the release, import, manufacture, and sale of certain toxic chemicals scheduled under the act. Environment Canada, which administers the act in cooperation with Health and Welfare Canada, maintains an inventory of environmental contaminants being used or manufactured in Canada. Notification is required by persons intending to use or import scheduled substances.

Canada Water Act

Part III of the Canada Water Act, dealing with phosphorus in detergents, has been incorporated into CEPA, otherwise the act continues as before. The act provides for cooperative management of water resources by the federal and provincial governments. Agreements such as the FREMP agreement have been developed under one of the four parts of this legislation. The water quality guidelines developed through the Canada Council of Resource and Environment Ministers were also developed under this legislation. The act also provides for coordination and integration of federal and provincial water quality monitoring activities on a cost shared basis. Water quality monitoring sites have been established upstream of Hope under such an agreement.

Transportation of Dangerous Goods Act

The Transportation of Dangerous Goods Act establishes a shipping manifest system for the provincial, national, and international movement of dangerous goods and provides substantial penalties in the event that they are illegally handled or transported. Goods are classified into one of nine categories, each requiring special labelling and documentation, depending on the materials characteristics. The consignor must provide the carrier with appropriate documentation for each shipment, and training and certification are required for individuals handling or transporting dangerous goods.

Pest Control Products Act

The Pest Control Products Act regulates the storage, manufacture, distribution, and use of pesticides in Canada, and provides authority to achieve this. Regulations may describe the form, composition, and standards of control products, as well as the conditions of their storage and use. The Department of Agriculture administers the act.

Fisheries Act

The Fisheries Act provides authority for management of fisheries resources and protection of fish and fish habitat. It is the country's principal federal legislation for the protection of water quality and fish habitat and applies to all the waters of Canada frequented by fish, whether used commercially, recreationally, or as a native food fishery.

The act defines fish as shellfish, crustaceans, marine animals and the eggs, spawn, spat, and juvenile stages of fish, shellfish, crustaceans, and marine animals. The B.C. government has been delegated responsibility for the management of freshwater sport fisheries with the federal government having responsibility for tidewater fisheries, marine fish habitat management, and freshwater habitat utilized by anadromous species.

Effective December 1988 the Fisheries Act was revised so that the numbering of many sections is changed. Sections 34 to 42 (formerly Sections 33 to 33.4) constitute the pollution prevention provisions of the act, and serve to control the contamination of fisheries waterbodies. Section 36 (3) (formerly Section 33 (2)) prohibits the deposit of deleterious substances into waters frequented by fish. These sections of the act are administered by Environment Canada in cooperation with the Department of Fisheries through a Memorandum of Understanding. Section 35 (formerly Section 31) of the act provides protection provisions by prohibiting any work or undertaking that may result in the harmful alteration, disruption, or destruction of fish habitat.

Under Section 34 (2) and 36 (5) (formerly Section 33 (12 and 13)) Canada's Governor in Council may make regulations which prescribe quantities, concentrations, or types of treatment to be applied to various deleterious substances released from specified industries (e.g. mining, pulp and paper). Thus regulations have been established under this act for effluent discharge levels from pulp mills, chloralkali plants, and mines. By mutual consent, the federal government attempts to implement its regulations through the provincial permit system, but retains the right to act unilaterally where the regulations are not being implemented, or where there is a direct threat to fish and/or fish habitat.

Canada Shipping Act

The Canada Shipping Act, administered by Transport Canada, is used to provide pollution control to maritime transport and safety aspects of recreational boating. Regulations under the act are specific to oil pollution prevention, dangerous goods shipping, and the discharge of general pollutants from ships (sewage, oil, garbage, chemicals). The discharge of sewage from recreational boats is regulated in the Great Lakes but not in B.C. waters.

Canada is preparing to accede to the Marpol Agreement which will result in further control of oil, bulk cargoes, and garbage and will also introduce controls over packaged chemicals and sewage from all commercial shipping in navigable waters. Shipping operated within four miles of the nearest shoreline will require sewage holding tanks or on-board treatment plants. Similar regulations will be promulgated for sewage discharge from pleasure craft. The province will designate environmentally sensitive waterways for selective enforcement of holding tank regulations.

5.3 Provincial Legislation

Constitution Act

Through the Constitution Act, the provincial proprietary jurisdiction applies to all land, water, forests, minerals, and land covered by water. Provincial jurisdiction also applies to the foreshore and beds of inland coastal waters. This has resulted in the establishment of a legislative framework which regulates users of water and land in the province. Thus the Environment Management Act, the Waste Management Act, the Water Act, and the Health Act, among others, have come into being.

Environment Management Act

The Environment Management Act enables the Ministry of Environment to establish a broad approach to environmental management and to streamline environmental and

developmental decision processes. It also enables the Ministry to take action in case of environmental emergencies. The basic elements of the act include provisions to develop environmental management plans and assessments and to take action to prevent environmental damage. The act also provides authority to recover costs for environmental emergencies and to hold public hearings and enquiries. The act established the Environmental Appeal Board to hear appeals on provincial environmental decisions. Water Quality Objectives for site specific fresh, estuarine, and coastal marine surface water bodies are being established under the mandate derived from the Environmental Management Act to manage water quality in the province (Appendix 4).

Waste Management Act

The Waste Management Act (WMA) replaced the Pollution Control Act as the basic instrument for controlling the discharge of pollutants to the receiving environment. Discharge permits may be issued for any discharge of contaminants to land, water, or air. Under the act, the Waste Management Branch can define what constitutes a polluted condition of water, land, or air and prescribe limits for discharge of various types of emissions and effluents. Pollution Control Objectives serve as the basis for establishing waste discharge concentrations which are authorized through permits, waste management plans, or orders. The branch also conducts tests and surveys to determine the extent of pollution, examines existing and proposed means for disposal of contaminants, and approves plans for such undertakings. Permits issued under the act contain terms and conditions under which discharges can occur, including effluent limits and monitoring requirements.

The act provides the basis for the Special Waste Regulation which controls the treatment and disposal of wastes that are potentially hazardous to human health and the environment and which require special care during handling and disposal. These are wastes which should not be sent to ordinary landfills or to sewer systems. Management options for these wastes have been developed and a guide has been prepared (MOE, 1988). Recommendations of a Public Waste Advisory Committee which was convened to review and report to the Minister of Environment are being implemented by the Waste Management Branch (Special Waste Advisory Committee, 1988) (Appendix 7).

The act also forms the legislative basis for the GVRD Solid Waste Management Plan (SWMP), approved by the Minister and in place, and the Liquid Waste Management Plan (LWMP) which is being developed. If approved, these plans replace the permitting system which currently exists for sewage treatment plants and for landfills. Responsibility for design and operation of treatment facilities remains with the GVRD, however more responsibility for monitoring, research, technical development, and public review would rest with the GVRD than is historically the case. The GVRD is also authorized under this act to enact bylaws for the regulation of discharge of substances to sewers and drains, and is delegated authority to regulate air emissions within the region (Appendix 4).

Water Act

The Water Act governs the use of water, both surface and groundwater, in British Columbia. Under the act the province retains all rights to water except where the right to its use is granted by a water licence issued by the Water Management Branch, Ministry of Environment. A licence is issued for a particular purpose, a particular source, and, where applicable, a specified quantity.

Health Act

The Health Act addresses the provision and control of health services in the province, but also regulates sewage disposal to land systems of less than 22.7 m^3/day. Regulations under the act provide design criteria to evaluate systems which are also constructed,

maintained, and monitored under approval from the Health Act. Remedial action to poorly functioning sewage disposal systems can be required under this act.

Pesticide Control Act

The Pesticide Control Act is administered by the Ministry of Environment, and provides for control of pesticide use through permitting procedures. The act also allows control of pesticide distribution through training, licences, and certificates. A Pesticide Control Committee oversees a federal/provincial referral system that requires a 10 m Pesticide Free Zone surrounding waterbodies.

Agricultural Acts

Acts administered by the Ministry of Agriculture and Fisheries include the Agricultural Land Commission Act, which creates agricultural land reserves, and the Soil Conservation Act, which prohibits soil removal or fill from these areas unless a permit is obtained.

Offence Act

The Offence Act contains schedules that designate enforcement officers, describe offences, and prescribe penalties for a number of provincial statutes including the Waste Management Act and the Pesticide Control Act.

5.4 Municipal Legislation

Municipal governments have a key role to play in managing the discharge of pollutants to the receiving environment. Through the Municipal Act, municipalities achieve pollution control and abatement through the enactment of bylaws which regulate many phases of solid and liquid waste management. Bylaws may include sewer use, stormwater discharge, building code, construction, and dumping restrictions. The Waste Management Act enables the establishment of Sewer Control Areas, as has been done for the Greater Vancouver Sewerage and Drainage District. The WMA (Sec 3 and 16) also enables creation of Waste Management Areas following provincial approval of a Waste Management Plan. The GVRD has prepared a Solid Waste Management Plan and is in the process of developing a Liquid Waste Management Plan under this part of the act. The WMA (Sec 19) authorizes the GVRD to control air emissions in the region. Further, the GVS and DD Act governs the admission of waste to sewers. Bylaws and regulations under the Municipal Act are without effect if they conflict with the WMA, except when such a bylaw, regulation, order, or permit imposes further restrictions or requires further conditions.

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Appendix 6 Enforcement and Compliance

Enforcement and compliance activities are undertaken in the FREMP study area by several agencies including the provincial Waste Management Branch and Conservation Officer Service, the federal Department of Fisheries and Oceans and Environmental Protection of Environment Canada, the GVRD, and individual municipalities. The legislative basis for these activities has been discussed in Appendix 5.

Regulation of deleterious substances entering the Fraser is principally controlled through the Waste Management Act administered by the Waste Management Branch. The intent of the federal Fisheries Act is observed through the Waste Management Act, though federal officials may act unilaterally on need. Compliance and enforcement of Waste Management Act permit conditions are carried out through a policy and procedure developed to encourage consistent upgrading of effluents to meet all permit conditions. This is achieved through a series of actions based on the severity of impact to the environment and the level of noncompliance. The main technique for attaining compliance is through negotiation and bargaining with legal action being a secondary strategy. Actions may be informal such as sending a letter or scheduling a meeting with senior officers of a permittee, or may be formal legal action through ticketing or prosecution (Table 6.1). Sections 35 and 36 of the Fisheries Act (formerly Sections 31 and 33) are administered by the federal Fisheries and Environment departments. A total of 62 charges were laid under these sections in the FREMP area during the period 1979 to 1986 (Table 6.2).

The Canadian Environmental Protection Act was proclaimed June 30, 1988. However, the regulations under the Clean Air Act, the Environmental Contaminants Act, and parts of the Canada Water Act are still administered under the original enactments. Federal policy is to work first through provincial statutes where possible. Provisions of CEPA which are principally administered through provisions of the Waste Management Act or other Provincial legislation can take the place of CEPA if they meet the conditions of "Equivalency" as described in the act. B.C. does not currently have equivalency status. The powers of investigation and enforcement in the CEPA legislation are very comprehensive particularly as they apply to the control of toxic chemicals which are listed as priority chemicals. No charges have been laid in the FREMP study area under CEPA however one charge was laid for PCB contamination in 1986 under the Environmental Contaminants Act.

Table 6.1 CHARGES AND TICKETS UNDER THE WASTE MANAGEMENT ACT, FREMP AREA

	1984	1985	1986	1987	1988	1989
Charges:						
Counts:	3		4			1*
Convictions:	2		2			
Stays:	1		2			
Total Fines:	$3000		$2500			
Tickets:						
Cases:				16	43	54
Tickets:				16	41	26*
Total Fines:				$3050	$5700	$2100*

* Some 1989 cases still in process. (Source: Waste Management Branch files)

Table 6.2 HABITAT CHARGES UNDER THE FISHERIES ACT: FREMP STUDY AREA

	1979	1980	1981	1982	1983	1984	1985	1986
SECTION 35								
Corp/Individuals charged:		6	7,1*	1	2,2*	2	1,4*	3,4*
Convictions:		2	3		1	2	1	1
Acquittals:		4	5	1	2		1	1
Stays:							1	4
Fines:		20	.5K		CD	.2K	.3K	1K
		CD	1K			CD		5K
			3K					
SECTION 36(3)								
Corp/Individuals charged:	1	6	6,1*	2	3,2*	5	3,4*	3,4*
Convictions:	1	3	4	1	3	3	2	4
Acquittals:		1	1	1	2	2	4	1
Stays:		2	2				1	2
Fines:	140K	4K	5K	18K	.5K	.1K	.5K	.2K
		8K	15K		1K	10K	7.5K	.5K
		20K	35K		2K	20K		1.5K
								3K
								30K
TOTAL Corp/Individuals charged under s. 35 & 36(3):	1	12	14	3	7	7	8	10

NOTES:

* Corporations/Individuals charged under both s. 35 and s. 36(3); therefore the total number of charges under the Fisheries Act for a given year (e.g. 1986) is the s. 35 number (3) + s. 36(3) number (3) + the number charged under both sections (4) = 10 corporations/individuals charged in 1986.

CD Conditional Discharge, no fine levied.

K $1000.00

Fisheries Act revised effective December, 1988. Sections 35 and 36(3) are formerly Sections 31 and 33(2).

(Source: Department of Fisheries and Oceans files, 1989)

There is no enforcement or compliance policy or strategy which is used in a cooperative manner by the agencies involved in FREMP. DOE and DFO have a memorandum of understanding for joint administration of Section 36 (3) (formerly Section 33) of the Fisheries Act, and the Conservation Officers of MOE are empowered to enforce this section of the act also. Beyond this, there is no formal cooperative approach to compliance and enforcement. In many areas of enforcement, there is an informal consultation between agencies of both governments, and the general policy has been for the federal government to defer to the province where legal action is contemplated. The B.C. Ministry of Environment is presently developing a policy for compliance and enforcement for all of its legislation. The federal Department of Fisheries and Oceans is also developing enforcement and compliance policies to provide guidance to departmental officials in the enforcement of the habitat provisions of the Fisheries Act, in order to ensure that the sections are applied in a fair, predictable, and consistent manner. A subcommittee with membership from the Waste Management Activity Program and the Standing Committee on the Fraser River Estuary Water Quality Plan has been formed to report on enforcement and compliance issues in the estuary.

Illegal discharges to the Fraser or its tributaries are not being investigated in an organized manner. Reports of illegal discharges are investigated, however no surveillance efforts are made on a routine basis by any agency and no active search for these discharges is being made at this time. Some plans are in place for surveillance strategies, particularly in the North Fraser Harbour, but these are not completely implemented.

Waste Management Branch Permit Procedure:

With some exceptions, no person may introduce waste into the environment without obtaining a permit in compliance with the Waste Management Act. The usual permit types issued by the Waste Management Branch include air, effluent, discharges to ground, and refuse permits, though air emission controls for the GVRD have been delegated to the District. General permitting procedure usually includes pre-application discussions and negotiation between applicant and Waste Management to inform the applicant of what is required and to derive permit conditions acceptable to both parties within these constraints. Guidance for Waste Management Branch permit writers is provided by the Pollution Control Objectives and by Water Quality Objectives where these are relevant. An application is submitted along with the permit fee and reviewed by Waste Management staff for completeness, assessed for impacts, and examined for adherence to Pollution Control Objectives. Notices regarding the application are posted at the site, published locally and in the B.C. Gazette, referred to interested agencies for comments, and served personally to any affected persons. The decision on permit issuance or denial is published.

Permits are issued for an indefinite period, but are reviewed regularly for changes, compliance, objections, and equity. Amendments may be made at the initiative of the Regional Waste Manager or reviewed at the request of the permittee. The opportunity to upgrade permits may be taken at these times, or a permit may be reviewed for this reason at the discretion of the Regional Waste Manager.

Permittees are responsible for monitoring their effluents on an agreed-upon schedule. This involves the sampling of effluents and submission to a lab for analysis, results are forwarded to WMB. An audit procedure involves a split sample with half sent by the permittee to its usual lab, and half sent to B.C. Research by the Waste Management Branch. Analysis results are compared to check lab performance, and compared to previous permittee sampling data to check effluent quality.

Table 6.3 SUMMARY OF WMB PERMITS ISSUED FOR FREMP AREA

Reach	Effluent to surface waters		Effluent to ground		Refuse	
	Municipal	Industrial	Municipal	Industrial	Municipal	Industrial
Main Stem	2	11	9	5	4	6
Main Arm	10	26	2	5	1	13
North Arm	0	23	1	9	0	5
Outer Banks	2	1	1	0	1	0
Boundary Bay	0	8	3	8	0	1
TOTAL	14	69	16	27	6	25

Appendix 7 Special Wastes

Special wastes are defined as hazardous goods that require special treatment or storage prior to disposal. British Columbia controls generation and storage of special wastes under the Special Waste Regulation of the Waste Management Act that was effective April 1, 1988. Classification is based on the federal Transportation of Dangerous Goods Act, except radioactives which are handled by the AECB, and including additional classes (Table 7.1). Included in the definition are waste oils and solvents from vehicle service, transportation, and printing industries; acids and bases from petroleum and chemical companies; heavy metals and chemicals in sludges from manufacturing facilities; wastes containing significant quantities of solvents, ketones, chlorinated hydrocarbons, pesticides, mercury, lead, zinc, cadmium, arsenic, and cyanide. Many special wastes end up in landfills, sewage treatment facilities, illegal dump sites, and eventually in groundwater and the Fraser estuary. Historically, landfills have been used by industry and the public as an acceptable disposal method for some types of special wastes. However, governments in North America are now closing such existing landfills because of groundwater and runoff pollution concerns. In B.C., wastes prohibited from disposal in a secure landfill or long term storage facility include liquids; containers, unless reduced in volume; ignitable, reactive, or radioactive wastes; wastes containing greater than 1% of total organic carbon, unless naturally contained in soil or not a special waste; wastes containing greater than 1 part in 1000 of halogenated organic compounds; or wastes which produce leachates with contaminant concentrations higher than specified amounts when subjected to a special waste extraction procedure (Table 7.2). The only alternative for continued operation of landfills is for the collection, safe treatment, and disposal of these special wastes before they enter the landfills. This needs to occur through public and industrial efforts toward safe disposal. Collection and proper disposal of these wastes is the intent of the provincial Special Waste Regulation.

The Waste Management Branch is reducing the input of special wastes through a number of initiatives as recommended by the Special Waste Advisory Committee. The options being implemented include the establishment of a special waste disposal facility in B.C., educational initiatives, research, regulation, enforcement, and monitoring. A final technical report is now before the Minister, but a site for a B.C. Special Waste Facility has not been determined. It is hoped a facility will be in operation by 1991. The WMB in Surrey has contacted all industries that may generate or store special wastes in the Lower Mainland Region, informed them of the Special Waste Regulation, and registered them as required. This initiative also had the advantage of increasing awareness of the special waste issue.

The absence of a Special Waste Disposal Facility in British Columbia has left industries, businesses, municipalities, and institutions with the options of disposal out-of-province, which may not be available in the future; storage, which may be impractical depending on quantity; treatment, if suitable and practical technology exists or can be developed; or illegal disposal, which creates health and environmental hazards. In June 1990 a B.C. Hazardous Waste Corporation was created by the provincial government to address these issues.

Household Hazardous Wastes

Though there is no official definition of household hazardous wastes, they are usually considered to be special wastes originating from households. Included are household cleaners, fuels, oils, batteries, solvents, pesticides, herbicides, pharmaceuticals, and other miscellaneous substances. The B.C. Special Waste Regulation does not apply to refuse collected by or on behalf of a municipality from residential premises, or to quantities of special waste less than 5 kilograms or 5 liters produced in a period of less than 30 days. Four options for dealing with household hazardous wastes include storage, disposal with household garbage, disposal down the sewer, or special collection. Continued storage of

certain wastes may be hazardous to the householder, and should not be encouraged. Disposal with regular household solid or liquid waste may present environmental, health, and safety hazards, though these could be reduced if the right choice between sewer and garbage disposal is made (Jacob, 1989). However, several household hazardous wastes require special treatment prior to disposal and need to be collected in a safe and organized manner.

Municipalities in the FREMP area, including those that offer pick-up or drop-off services to their residents, have differing ways of dealing with household hazardous wastes. All municipalities first refer enquiries to the provincial Waste Management Branch. The GVRD is investigating household hazardous waste programs. Jacob (1989) has investigated the issues and compiled national and international case studies of household hazardous waste management. During 1990, a number of one-time hazardous waste collection events co-sponsored by the Ministry of Environment and the GVRD were held throughout the region.

The B.C. Ministry of Environment's Waste Management Branch collects household hazardous waste at designated depots, including Surrey which serves the FREMP area. Government employees at the Waste Management Branch ensure that material is properly labelled, packaged for transport, and manifested as required under the Transportation of Dangerous Goods Act and Regulations. Wastes are received by appointment to ensure that an environmental safety officer is on hand to properly deal with the waste. Some collected wastes are disposed of locally, others are transported by a private company out-of-province for disposal at government expense.

There is a need for public awareness regarding what constitutes a household hazardous waste, what the hazardous aspects are, what less hazardous alternatives are available, and the proper disposal of hazardous wastes. There is a need to advertise existing hazardous waste collection programs and to develop more effective and convenient programs.

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Table 7.1 B.C. SPECIAL WASTE CLASSIFICATION

	TDG Act Class*	Waste Name
1.	1	Explosives
2.	2.1	Flammable compressed gases
3.	2.2	Nonflammable gases
4.	2.3	Poisonous gases
5.	2.4	Corrosive gases
6.	3.1	Flammable liquids, flashpoint < -18 C
7.	3.2	Flammable liquids, flashpoint < 23 C
8.	3.3	Flammable liquids, flashpoint < 37.8 C
9.	4.1	Flammable solids
10.	4.2	Spontaneous combustibles
11.	4.3	Dangerous when wet
12.	5.1	Oxidizers
13.	5.2	Organic peroxides
14.	6.1	Poisonous substances
15.	6.2	Infectious substances
16.	8	Corrosives
17.	9.1	Miscellaneous
18.	9.2	Hazardous to environment
19.	9.3	Dangerous wastes
20.		Waste asbestos
21.		Waste oil
22.		Waste pest control products
23.		Waste pest control product containers
24.		Leachable wastes

* Canada Transportation of Dangerous Goods Act (1979)

(Source: Special Waste Regulation Schedule 6)

Table 7.2 MAXIMUM LEACHATE CONCENTRATION FOR MATERIALS SUBJECT TO SPECIAL WASTE EXTRACTION PROCEDURE

	Contaminant	Concentration in Waste Extract (mg/L)
1.	2,4,5-TP/Silvex/2-(2,4,5-Trichlorophenoxy) propionic acid	1
2.	2,4-D	10
3.	Aldrin + Dieldrin	0.07
4.	Arsenic	5
5.	Barium	100
6.	Boron	500
7.	Cadmium	0.5
8.	Carbaryl/1-Naphthyl-N-methyl carbamate/Sevin	7
9.	Chlordane	0.7
10.	Chromium	5
11.	Cyanide (free)	20
12.	DDT	3
13.	Diazinon/Phosphordithioic Acid,0,0-diethyl 0-(2-isopropyl 6-methyl-4-pyrimidinyl) ester	0.02
14.	Endrin	0.02
15.	Fluorides	150
16.	Heptachlor and Heptachlor epoxide	0.3
17.	Lead	5
18.	Lindane	0.4
19.	Mercury	0.1
20.	Methoxychlor/1,1,1-trichloro-2,2-bis (p-methoxyphenyl) ethane	10
21.	Methyl Parathion	0.7
22.	Nitrate + Nitrite	1000
23.	Nitrilotriacetic acid	5
24.	Nitrite	100
25.	PCBs	0.3
26.	Parathion	3.5
27.	Selenium	1
28.	Silver	5
29.	Toxaphene	0.5
30.	Trihalomethanes	35
31.	Uranium	2

(Source: Special Waste Regulation-Schedule 4, Table 1)

Appendix 8 Sewage Treatment Plant Effluents

8.1 Introduction:

Most municipal sewage generated in the FREMP area is routed through three Greater Vancouver Sewerage and Drainage District (GVS&DD) sewage treatment plants (STP). Influent sewage to these plants is from a varying mix of domestic, industrial, commercial, and institutional sources. The Iona Island plant was constructed during 1961-1963, the Lulu Island plant started operation in 1973, and the Annacis Island plant started in 1975. These plants consolidated a number of raw sewage outfalls into three large primary treated discharges. Over time, sewage influent to small secondary treatment plants operating in the area has been diverted to the primary treatment Annacis plant. Due to maintenance levels in small plants, diversion has been an improvement over previous operating conditions in spite of the decreased treatment level. These include the Ladner Lagoon, Deas Island, Maple Ridge, and Pitt Meadows plants. The Langley District Sewage Treatment Plant still discharges secondary treated effluent into the Main Stem in the upper estuary, though part has been diverted to Annacis. Marinas and other municipal-type outfalls discharging sewage also require permits from the Waste Management Branch.

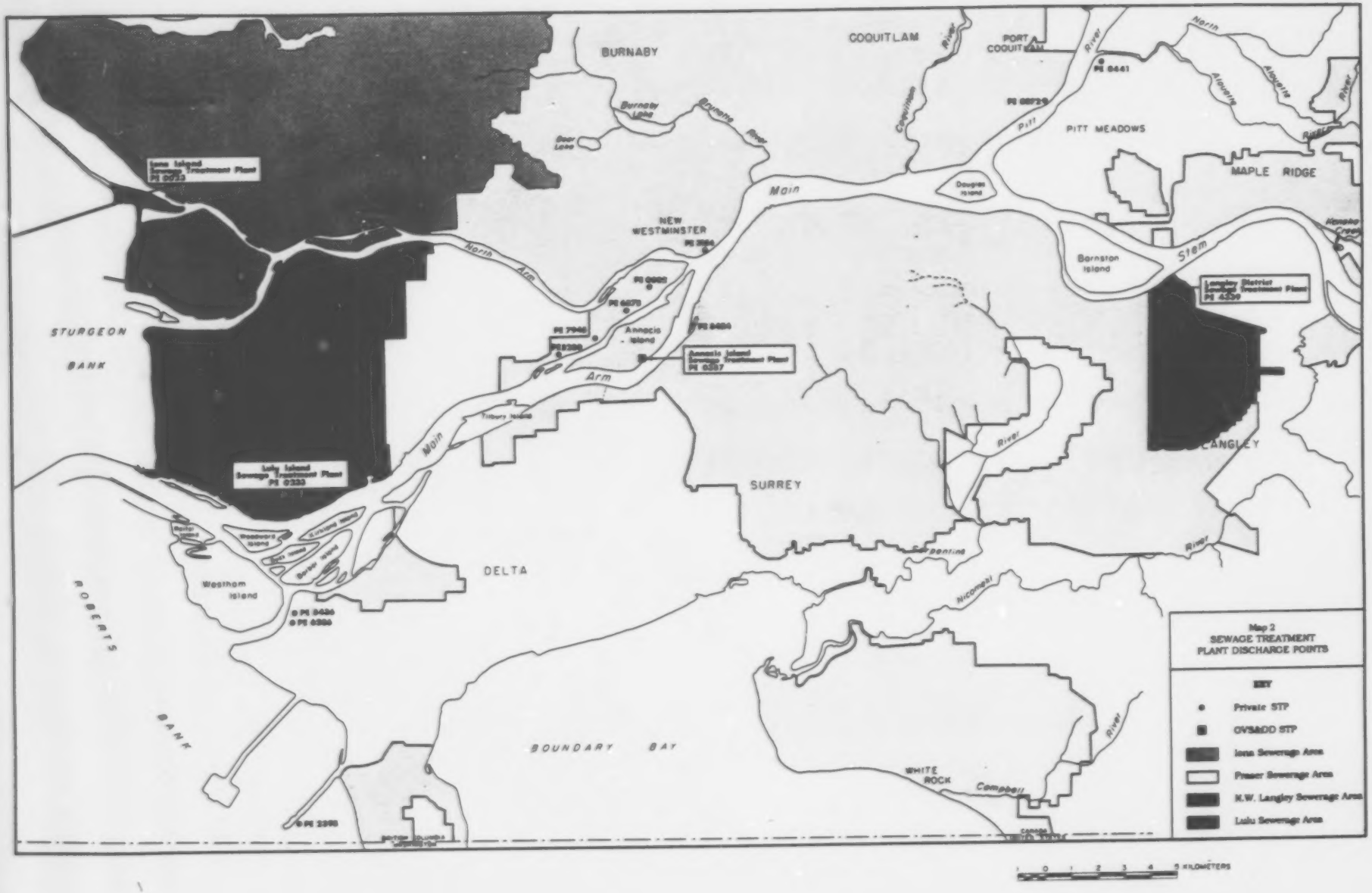
Primary treatment at the GVS&DD plants consists of screening incoming sewage, prechlorination to reduce odors, pre-aeration, sedimentation, sludge and grit removal, and, between May 1 and September 30, chlorination and dechlorination of clarified effluent. Sludge and scum are thickened, digested and dried in lagoons by the plants, and stored until disposal. Exceptions are at Lulu Island where the sludge is dewatered and incinerated, and at Iona, where the effluent is not chlorinated. Removal efficiencies at these plants is designed to be 35% of BOD5 and 60% of suspended solids, though in practice these efficiencies range from 25 - 35% and from 40 - 65%. Removal efficiency for coliforms approaches 99% during chlorination, ranges from 15 - 50% for metals, and may approach 10% for organics. Toxicity of effluents is generally not much reduced, and may be increased through presence of chlorine residues (Higgs, 1977).

8.2 Area Characteristics and Flows:

Each of Iona, Annacis Island, and Lulu Island sewage treatment plants serve discrete sewerage areas that vary in size, population, industrial composition, growth rate, and type of sewer system. These variables affect plant design and capacities, contaminant composition and concentration, and total flows. Not all area or population within GVS&DD boundaries is served by district facilities, service may be by alternate forms of sewage disposal such as septic tanks. Some infilling can be expected over the next 50 years (Table 8.1).

The Iona Island STP serves the Vancouver Sewerage Area (SA) consisting of the City of Vancouver, the University Endowment Lands, Vancouver International Airport, Mitchell Island, and part of the northwest portion of Burnaby (Map 2). This 13,500 ha area had a 1986 population of 465,000, with future projected populations expected to be stable about this level. Current Iona STP average dry weather flows (ADWF) of 466,798 m^3/day are within design parameters. Peak wet weather flow (PWWF) capacity is approximately four times as great as the dry weather average, but because of the combined sewer nature of the Vancouver SA, this capacity is often exceeded during storm events. Combined sewer overflows are discussed in Appendix 10.

Formerly, effluent from the Iona Island STP was discharged into a drainage channel across Sturgeon Bank. This channel was uncovered at low tide but covered at high tide. A jetty along the north side of the channel prevented effluent from spreading to areas north of Iona Island for at least one tidal cycle. Due to this discharge of effluent, a zone of influence spread outwards from the Iona outfall and up to 3 km^2 of Roberts Bank became biologically degraded (Birtwell et al., 1983). As a result of action brought under the Fisheries Act by the


BURNABY
COQUITLAM
PORT COQUITLAM
PITT MEADOWS
MAPLE RIDGE
NEW WESTMINSTER
Barnston Island
Douglas Island
Annacis Island
STURGEON BANK
SURREY
DELTA
LANGLEY
Westham Island
ROBERTS BANK
BOUNDARY BAY
WHITE ROCK
Iona Island Sewage Treatment Plant PE 0223
Annacis Island Sewage Treatment Plant PE 0357
Lulu Island Sewage Treatment Plant PE 0233
Langley District Sewage Treatment Plant PE 4259
Fraser River
North Arm
Main Arm
Pitt River
Alouette River
Serpentine River
Nicomekl River
Campbell River
Map 2
SEWAGE TREATMENT
PLANT DISCHARGE POINTS
KEY
Private STP
GVS&DD STP
Iona Sewerage Area
Fraser Sewerage Area
N.W. Langley Sewerage Area
Lulu Sewerage Area
0 1 2 3 4 5 KILOMETERS

Musqueam Indian Band, and court ordered task force recommendations, in April 1988 an eight kilometer long deep sea outfall started discharging the Iona effluent into the Strait of Georgia at a depth of 100 meters. During summer, 1988, fecal coliform counts declined markedly for Vancouver beaches. While impacts on the estuary are much reduced, effects of the outfall are still being monitored and further measures may be required to protect receiving waters.

The Annacis Island STP serves the Fraser SA consisting of New Westminster, remaining parts of Burnaby, Coquitlam, Delta, Surrey, Maple Ridge, Pitt Meadows, Port Coquitlam, Port Moody, White Rock, Langley City and District, and east Richmond. This area of 55,000 ha (33,200 ha serviced) had a 1986 population of 596,000 (540,000 serviced) and a projected growth of 100% over the next 50 years. The current ADWF is well under design flows, but PWWF is occasionally exceeded during wet weather due to combined sewers in New Westminster. STP effluent flows of between 250,000 m^3/day and 570,000 m^3/day are discharged to the Main Arm of the Fraser River midway along the island via three pipes extending one quarter the 600 m river width. The six diffuser risers per pipe are 8.4 m below the mean low water level. The vertical orientation of the risers and generally warm effluent temperatures cause effluent to rise towards the surface of the river. Maximum flows occur during wet weather which is more common in winter when normal river flows are low. A portion of the Fraser Sewerage Area is served by the N.W. Langley STP which has an average discharge of 3,500 m^3/day.

The Lulu Island STP serves the Lulu Island SA of west Richmond. The 1986 population of this 5900 ha area (3800 ha serviced) was 107,000 (93,000 serviced), with steady growth projected. The current ADWF is 60% of design, and the PWWF capacity is not exceeded as there are no combined sewer systems in the area, though infiltration of ground water into sanitary sewers does increase flows during wet weather. Effluent flows averaging 41,230 m^3/day are discharged into the Main Arm near its mouth via pipes extending one-third the 550 m distance to the Woodward Island training wall. The single outfall pipe has a four-port vertical diffuser system and each riser is 7.4 m or more beneath the surface.

Industrial and commercial hookups to sewer vary in these sewerage areas. Nondomestic sewage in the Vancouver SA is estimated to be 7.5% of dry weather flows to the Iona plant, originating primarily from food and beverage industries. Thirteen percent of the ADWF in the Fraser SA is from major industrial dischargers, defined as industries discharging more than 5 m^3/day or industries with known or suspected contaminants of concern. A decreasing trend is ongoing as steadily increasing domestic growth has combined with few further industrial sewer connections since the Annacis plant start-up. In the Lulu SA, major industries contribute 6.4% of the ADWF, and 22.5% of BOD5. Reports on industrial wastewater discharges to sewer include Atwater (1979), City of Vancouver (1979), and Jordon and Leclair (1986).

While most flows are from the GVS&DD STPs, 11 small municipal-type dischargers have permits in the FREMP area, with a total permitted discharge of 720 m^3/day. Most of this is to the Main Arm, with the remainder to the Main Stem (Table 8.6).

8.3 Loadings:

Cain and Swain (1980) reported on a variety of contaminant loadings for the FRES Phase 1 program. These data from 1976 to 1979 showed generally increasing trends for most parameters. Ongoing GVRD monitoring efforts have yielded contaminant concentration levels for a wide variety of substances (Tables 8.2, 8.3 and 8.4) (GVRD, 1988c). Using these figures, average daily flows of 466,789 m^3/day, 291,791 m^3/day, and 41,230 m^3/day for Iona, Annacis, and Lulu STPs respectively (WMB files), loading estimates are derived (Table 8.5). These figures are indicators only, as flows and concentrations vary. Higher flows diluted by stormwater or infiltration, as is more common in winter, would have different loading values.

Few loadings are reported from small municipal-type dischargers. 1987 WMB data shows all loadings to the Main Arm, consisting of BOD, NFR, chloride, ammonia, nitrite/nitrate, and phosphorus.

8.4 Issues:

The major issues associated with the GVS&DD sewage treatment plants are of concern because of the continuous large flows and loadings delivered to three discrete points, two within the estuary. Of sources within the estuary, the Annacis and Lulu Island STPs discharge the majority of BOD5, NFR, most metals, and, during winter when chlorination is suspended, fecal coliforms. Issues discussed below are contaminant levels and degree of treatment, permit noncompliance, industrial hookups to sewer, winter chlorination, and sludge processing and disposal. Iona STP effluent now impacts directly on the Strait of Georgia rather than the estuary. The significance of the impact is still being evaluated by an ongoing monitoring program.

Many contaminants are present in GVS&DD STP effluent though concentrations may be low. These concentrations lead to significant loadings as STP flows are large. STPs are required to meet the interim provincial level BB standards for municipal type waste discharges (PCB, 1975) (Tables 8.2, 8.3 and 8.4). Federal Department of Fisheries and Oceans officials do not believe that these standards are strict enough, as permitted contaminant levels lead to toxicity in the initial dilution zone. The issue of toxicity in the IDZ is a general concern, applying also to industrial effluents and stormwater discharges. The federal position holds that the usual toxicity criteria expressed as the Median Lethal Concentration that will cause the death of 50% of test fish in a given time, usually 96 hours (96hr LC50), is a limited one. LC50 tests are influenced by such variables as chemical formulations, species, condition, age, and sex of the test fish, and water quality. Values below the LC50 level remain toxic, the concentration at which the first death occurs may be well below this level. At yet lower concentrations, effects may be chronic though not acute. Chronic toxicity effects of reduced biological efficiency or reproductive failure may be as significant in the long run. Consequently, federal officials would prefer that no toxicity exist in an IDZ. Provincial officials and regional engineers feel that the IDZ concept allowing river dilution and assimilation within a small volume is a valid one, otherwise discharges would need to be of receiving water quality. Provincial principles for water quality objectives state that acutely toxic conditions should not occur in the IDZ, though level BB of pollution control objectives for municipal type discharges have a 96hr LC50 standard of 75%. The issue remains unresolved primarily because of the cost involved in meeting the objective of no toxicity in the IDZ.

Effluents from the GVS&DD STPs frequently contain higher levels of contaminants than permitted (Tables 8.2, 8.3 and 8.4). This permit noncompliance is most severe for BOD5, toxicity, oil and grease, and dissolved iron from the Annacis plant, and toxicity, oil and grease, dissolved iron, total aluminum, and total chromium from the Lulu plant. Conclusions of a Board conducting public hearing into pollution issues of the lower Fraser River in 1980 recommended that secondary treatment facilities be installed and that level AA of the Pollution Control Objectives be met for STPs by 1990 (Advisory Panel, 1980). Though higher levels of pollution control have been recommended in the past, the current lower levels are still not being met. Again, cost is a contributing factor.

Industrial and commercial hookups to sewer present concerns regarding potentially damaging substances in the system, hazards to sewerage workers and the public, potential plant upset from certain contaminants, treatment plant sludge quality, and receiving water quality. Industry and commercial sources contribute a high proportion of metals and organics relative to domestic sources.

Chlorination and subsequent dechlorination of effluent is performed during the summer period May 1 to Sept 30. This treatment is the most cost-effective way to reduce fecal

coliform levels. Chlorine residuals are highly toxic to fish, so chlorination is suspended when water-contact recreation or other pursuits are at a minimum. However, water-contact activities are growing in popularity in some areas of the estuary during the nonchlorination period. Also, studies in the U.S. have indicated that up to 2% of the chlorine used in chlorination may be converted to chlorinated organics. Dechlorination only addresses free residual chlorine, not the combined forms.

Sludge processing and disposal is becoming more of a problem as increasing population and industrial activity increases sludge amounts, as operating space becomes more limited, and as surrounding development impinges upon STP buffer zones. Contaminants removed from the influent sewage remain in the sludge, giving rise to concerns regarding sludge quality. Implementation of secondary or higher treatment at STPs will result in approximately twice the sludge volume as from primary treatment, though the quality of secondary sludge will remain comparable. This is because the secondary process captures more solids and bacteria, effectively diluting the increased quantity of metals and organics obtained. In addition, some of the toxic pollutants are broken down by the secondary process (PSWQA, 1986). Runoff from sludge storage areas apparently is not a problem. The amount of space available for sludge disposal is limited, and alternate methods for disposal are needed. Sludge disposal guidelines are being prepared by MOE.

8.5 Initiatives:

Since 1984, when the GVRD was designated a sewage control area under the WMA, the GVS &DD has had authority to regulate nondomestic discharges, at point of discharge, in all member municipalities. Such regulation could proceed under terms of a regional sewer use bylaw incorporating discharge criteria and permitting procedures. Draft regional bylaws have been circulated, but not approved, and the process has been tied into the current LWMP. In the meantime, the district has been able to bring major individual discharges to sewer under monitoring and control programs through issuance of Waste Management Act Orders. This is a time consuming process, however, and is limited in scope. Otherwise, regulation is through the GVS&DD Act which gives the GVS&DD authority to control nondomestic discharges to trunk sewers only, and through municipal sewer use bylaws enacted in 10 of the 12 GVS&DD municipalities that border the Fraser in the FREMP study area. Prohibition and restriction regulations promulgated by the GVS&DD in 1971 have been adopted into the bylaws of 2 municipalities, and are followed as unwritten policy by 5 others (Table 8.7).

Four municipalities, Burnaby, Delta, Langley Township, and Vancouver, have proactive source control programs incorporating site inspections, monitoring, and enforcement activities. Two municipalities, Surrey and Langley Township, have incorporated industry surcharges into their sewer use bylaws. In Surrey, the program deals with high volume and BOD from a poultry processing plant by charging for water consumption beyond a certain level. In Langley, users are charged for BOD and suspended solids beyond a concentration of 300 mg/L, and charged $2.20 per 4.5 m^3 (1000 imp gal) of flow. Since fees went into effect in October 1987 there has been a noticeable decrease in water consumption and an improvement in housekeeping and waste handling techniques at some industries (GVRD, 1988d). Most municipalities charge a flat annual rate for use of their sewer facilities.

The GVRD Liquid Waste Management Plan is a multistage process resulting in a fully developed waste management plan. Stage 1 reports now being circulated are a collection of existing information, an examination of existing conditions, a conceptual development of waste management options, and the presentation of waste management strategies. Stage 2, if entered as recommended by Stage 1, would entail a detailed examination of alternative facilities, and recommendations regarding capital works, management practices, and monitoring. Future stages may be entered as appropriate. The LWMP is primarily concerned with the GVS&DD infrastructure, including the adequacy of existing sanitary and

stormsewers, treatment plants, and nondomestic source control programs. Selected nonpoint source wastewaters are considered to provide a comparison basis.

Prerequisite to source control programs is an inventory of the number and type of industries discharging nondomestic wastewaters to sewer and the quantity and quality of the waste streams generated. A number of inventories have been done, and are summarized in the LWMP Source Control Committee report (GVRD, 1988d). Periodic updating of the industrial wastewater inventory and small commercial/industrial discharger survey is recommended by the Source Control Committee, and is done by the GVRD as resources allow.

8.6 Remedies:

Contaminant reduction to bring the STPs into permit compliance or to meet more stringent requirements can be realized by either source control or upgrading. A less satisfactory option to virtually eliminate impacts of the STPs on the estuary is the construction of a deep sea outfall. For these remedies to be developed and implemented with confidence, however, more information is needed about contaminant loading values, variations with respect to flow level and time of year, seasonal resource sensitivities, and effluent toxicity characterization. Needed is research to develop tests with lower detection limits, special extraction methods for organics and metals, and ambient environmental impact assessment in the vicinity of the outfalls.

Source control involves controlling influent sewage quality. The GVS&DD STPs are designed to deal with domestic sewage and effectively remove BOD, solids, and coliforms. Metals and organics are disproportionately contributed by commercial and industrial sewer hookups, and are the focus of source control regulations. Requiring pretreatment of nondomestic wastes prevents interference with biological STP treatment processes, reduces pass through of contaminants to receiving waters, increases sludge quality, and decreases direct contamination through CSOs in combined sewer areas. Pretreatment is generally more effective and cost efficient than STP end-of-line treatment because waste streams are simpler, less concentrated, have fewer synergistic effects, and operator familiarity with contaminants is greater. Source control can be equitable, in the sense that "the polluter pays." It is an incentive for waste reduction, especially if a sewer use variable charge system based on volume of flow and contaminant concentration, toxicity, persistence, mobility, or other aspects of risk is applied. It provides for better management of STPs due to better data regarding waste streams entering sewers, and possible emergency advance warning if malfunctions or spills occur. And it can enhance industry awareness regarding STP effluent issues.

Industry concerns about source control include uneven administrative requirements between municipalities which affect a company's ability to compete, and cost, space, and expertise limitations associated with program implementation. A prerequisite for source control is a viable B.C. special waste disposal system for wastes that are not discharged to sewer. Some form of source control is a prerequisite for STP upgrading to secondary or higher treatment. Source control for nondomestic sewer users is a priority of the GVRD LWMP.

The Waste Management Activity Program attaches a high priority to source control programs, and urges development and implementation of the LWMP initiatives. Foremost is to develop and implement a regional source control bylaw. Municipal bylaws including sewer use surcharges as economic incentives for reducing pollutant loads and water consumption have proved effective, and incorporation of surcharges into the regional bylaw should be considered.

Upgrading can be carried out on any of the component parts of sewerage collection, treatment, and disposal. A section by section analysis of the existing sewer collection system shows capacities are exceeded for some interceptors and pumping stations (GVRD, 1988a).

This may contribute to combined sewer overflows in combined sewer areas (see Appendix 10). Plant upgrading by enhanced primary treatment, biological or chemical secondary treatment, or tertiary treatment removes more contaminants from effluent, which are then disposed of in the sludge. Upgraded treatment facilities require more room, are costly to construct and operate, are more sensitive to influent flow variations, and are more prone to plant upset. Diffuser modifications to decrease port diameter and change direction of discharge from vertical to horizontal could enhance dilution of effluent contaminant levels in the IDZ thereby reducing toxicity.

The Waste Management Activity Program supports upgrading to secondary or higher treatment levels for the Annacis and Lulu Island STPs. Further upgrading at Iona will depend upon results of the deep sea outfall environmental monitoring program, which should be continued. Diffuser modifications should be evaluated, however, total contaminant loads would not be decreased and such modifications should not take precedence over source control or treatment upgrading options.

A deep sea outfall running twenty kilometers along the north shore of the Main Arm between the Annacis Island STP and the Strait of Georgia, connecting with Lulu Island STP, has been proposed. Such an outfall would be similar to the Iona Island STP outfall now in operation. An additional outfall may compound impacts from the current outfall on the Strait of Georgia, requiring treatment upgrading for all sewage treatment plants. A deep sea outfall would not preclude the necessity for source control programs, or of secondary treatment some time in the future. Effluents would be discharged into an area where monitoring is more difficult and where environmental effects are not known. Contaminant loading concerns are not addressed by a deep sea outfall, only the discharge location is moved. Consequently, construction of an additional deep sea outfall should not be considered a viable remedy for STP effluent issues.

The LWMP Sewage Treatment Upgrading and Sludge Disposal Committee (1988c) recommends evaluation of on-site incineration and off-site composting of sludge options. Sludge handling guidelines have been prepared by the Ministry of Environment. Groundwater contamination concerns stemming from sewage lagoon seepages are addressed in Appendix 12.

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Table 8.1 SUMMARY OF GVS&DD SEWAGE TREATMENT PLANTS, FREMP AREA

	Iona Island	Annacis Island	Lulu Island
Start-up Date	1963	1975	1973
Sewerage Area	Vancouver	Fraser	Lulu Island
SA Size 1986	13,200	33,200	3,800
SA Size 2036	13,500	42,500	5,200
SA Population 1986	465,000	540,000	93,000
SA Population 2036	473,000	992,000	146,000
Design ADWF	4.67	4.61	0.71
Current ADWF	4.36	2.88	0.4
2036 ADWF	5.33	5.38	0.68
Design PWWF	17.7	10.2	1.36

(Source: GVRD, 1988)

Notes:
ADWF: Average Dry Weather Flow
PWWF: Peak Wet Weather Flow
ADWF and PWWF given in cubic meters per second

Table 8.2 AVERAGE 1985 IONA ISLAND STP CONTAMINANT CHARACTERISTICS

PARAMETER	INFLUENT SEWAGE	EFFLUENT SEWAGE	PERMIT LEVEL	TIMES EXCEEDED (%)
Biochemical oxygen demand	nd	81	130	0
Suspended solids	nd	57	100	0
Kjeldahl nitrogen	20	16	na	na
Nitrate/Nitrite	<2	<2	na	na
Ammonia	10	8.8	na	na
Fluoride	0.15	0.16	na	na
MBAS	1.5	0.9	na	na
Sulphate	27	26	na	na
Calcium carbonate (alkalinity)	83	72	na	na
pH	nd	7.2	6.5-8.5	0
Phosphorus (diss)	2	1.8	na	na
Phosphorus (total)	3.5	2.9	na	na
Oil and Grease	27*	16*	20	8.3
Phenol	0.03*	0.03*	0.4	0
Cyanide (total)	<0.02*	<0.02*	0.5	0
Sulfide (diss)	<0.04-1.16*	<0.04-0.30*	1	0
Boron (diss)	0.17	0.16	5	0
Aluminum (diss)	<0.5	<0.5	na	na
Aluminum (total)	1.0	<0.5-1.3	4	0
Arsenic (diss)	<0.02	<0.02	na	na
Arsenic (total)	<0.02	<0.02	0.25	0
Barium (diss)	<0.05	<0.05	1.0	0
Cadmium (diss)	<0.0005-0.0012	<0.0005-0.0015	0.01	0
Cadmium (total)	0.0017	<0.0005-0.0015	na	na
Chromium (diss)	<0.05	<0.05	na	na
Chromium (total)	<0.05	<0.05	0.3	8.3
Cobalt (diss)	<0.05	<0.05	0.5	0
Cobalt (total)	<0.05	<0.05	na	na
Copper (diss)	0.03	0.04	0.5	0
Copper (total)	0.15	0.10	na	na
Iron (diss)	0.37	0.29	1.0	0
Iron (total)	1.47	0.89	na	na
Lead (diss)	<0.005-0.049	<0.005-0.027	na	na
Lead (total)	0.056	0.042	0.1	8.3
Manganese (diss)	0.05	0.05	0.5	0
Manganese (total)	0.07	0.06	na	na
Mercury (total)	<0.0005-0.0060	<0.0005	0.002	0
Molybdenum (diss)	<0.03	<0.03	na	na
Molybdenum (total)	<0.03	<0.03	0.5	0
Nickel (diss)	<0.05	<0.05	0.5	0
Nickel (total)	<0.05	<0.05	na	na
Selenium (diss)	<0.025	<0.025	na	na
Selenium (total)	<0.025	<0.025	0.1	0
Silver (diss)	<0.02	<0.02	na	na
Silver (total)	<0.02	<0.02	1.0	0
Tin (diss)	< 1	< 1	na	na
Tin (total)	< 1	< 1	10	0
Zinc (diss)	0.07	0.08	na	na
Zinc (total)	0.16	0.12	5.0	0
Toxicity	nd	>96*	75	8.3

NOTES:
Based on GVRD monthly analysis data.
Units are mg/L except pH, and Toxicity which is expressed as 96hr LC50 %v/v.
Toxicity tests done by B.C. Research.
Range given where average indeterminate (see below).
* grab sample, all others composited proportional to flow over 24 hours.
na not applicable
nd no data
Calculation of Average Values:
- Average less than detection limit if most individual results were less than detection limit with statistically insignificant number near detection limit.
- Average indeterminate if individual values equally distributed between less than values and finite values.
- Average calculated if most individual values were finite with statistically insignificant number below the detection limit, these were assigned the detection limit value and used in the calculation.

(source: GVRD, 1988c:Table 6.5, 6.6, 6.7)

Table 8.3 AVERAGE 1985 ANNACIS ISLAND STP CONTAMINANT CHARACTERISTICS

PARAMETER	INFLUENT SEWAGE	EFFLUENT SEWAGE	PERMIT LEVEL	TIMES EXCEEDED (%)
Biochemical oxygen demand	nd	156	130	79.9
Suspended solids	nd	71	130	0
Kjeldahl nitrogen	28	26	na	na
Nitrate/Nitrite	<2	<2	na	na
Ammonia	13.7	16	na	na
Fluoride	0.15	0.15	na	na
MBAS	1.6	1.9	na	na
Sulphate	35	27	na	na
Calcium carbonate (alkalinity)	110	106	na	na
pH	nd	6.9	6.5-8.5	0
Phosphorus (diss)	2.9	3.1	na	na
Phosphorus (total)	5.1	4.5	na	na
Oil and Grease	41*	29	30	41.7
Phenol	0.07*	0.05	0.4	0
Cyanide (total)	<0.02*	<0.02	0.5	0
Sulfide (diss)	<0.04-0.48*	<0.04	1	0
Boron (diss)	0.29	0.29	5	0
Aluminum (diss)	<0.5	<0.5	na	na
Aluminum (total)	1.3	0.8	4	0
Arsenic (diss)	<0.02	<0.02	na	na
Arsenic (total)	<0.02	<0.02	0.25	0
Barium (diss)	<0.05	<0.05	1	0
Cadmium (diss)	<.0005	<.0005	0.01	0
Cadmium (tot)	0.0009	<0.0005-0.0019	na	na
Chromium (diss)	<0.05	<0.05	na	na
Chromium (total)	<0.05	<0.05	0.3	0
Cobalt (diss)	<0.05	<0.05	0.5	0
Cobalt (total)	<0.05	<0.05	na	na
Copper (diss)	0.04	0.05	0.5	0
Copper (total)	0.19	0.14	na	na
Iron (diss)	0.78	0.81	1	25
Iron (total)	2.38	1.8	na	na
Lead (diss)	0.01	0.013	na	na
Lead (total)	0.069	0.042	0.1	0
Manganese (diss)	0.07	0.07	0.5	0
Manganese (total)	0.11	0.1	na	na
Mercury (total)	<0.0005-0.0012	<0.0005	0.002	0
Molybdenum (diss)	<0.03	<0.03	na	na
Molybdenum (total)	<0.03	<0.03	0.5	0
Nickel (diss)	<0.05-0.15	<0.05-0.15	0.5	0
Nickel (total)	<0.05-0.15	<0.05-0.15	na	na
Selenium (diss)	<0.025	<0.025	na	na
Selenium (total)	<0.025	<0.025	0.1	0
Silver (diss)	<0.02	<0.02	na	na
Silver (total)	<0.02	<0.02	1	0
Tin (diss)	<1	<1	na	na
Tin (total)	<1	<1	10	0
Zinc (diss)	0.06	0.1	na	na
Zinc (total)	0.13	0.17	5	0
Toxicity	nd	<56 - >100	75	50

NOTES:
Based on GVRD monthly analysis data.
Units are mg/L except pH, and Toxicity which is expressed as 96hr LC50 %v/v.
Toxicity tests done by B.C. Research.
Range given where average indeterminate (see below).
* grab sample, all others composited proportional to flow over 24 hours.
na not applicable
nd no data
Calculation of Average Values:
- Average less than detection limit if most individual results were less than detection limit with statistically insignificant number near detection limit.
- Average indeterminate if individual values equally distributed between less than values and finite values.
- Average calculated if most individual values were finite with statistically insignificant number below the detection limit, these were assigned the detection limit value and used in the calculation.

(source: GVRD, 1988c:Table 4.5, 4.7, 4.8)

Table 8.4 AVERAGE 1985 LULU ISLAND STP CONTAMINANT CHARACTERISTICS

PARAMETER	INFLUENT SEWAGE	EFFLUENT SEWAGE	PERMIT LEVEL	TIMES EXCEEDED (%)
Biochemical oxygen demand	nd	139	169	6.5
Suspended solids	nd	64	128	0
Kjeldahl nitrogen	34	30	na	na
Nitrate/Nitrite	<2	<2	na	na
Ammonia	20.5	19.8	na	na
Fluoride	0.14	0.14	na	na
MBAS	2	2.1	na	na
Sulphate	35	36	na	na
Calcium carbonate (alkalinity)	123	110	na	na
pH	nd	6.9	6.5-8.5	5.7
Phosphorus (diss)	3.1	3.3	na	na
Phosphorus (total)	5.8	5.3	na	na
Oil and Grease	49*	31*	30	58.3
Phenol	0.05*	0.04*	0.4	0
Cyanide (total)	<0.02-0.11*	<0.02*	0.5	0
Sulfide (diss)	<0.04-1.0*	<0.04-0.80*	1	0
Boron (diss)	0.33	0.31	5	0
Aluminum (diss)	<0.5-2.9	0.8	na	na
Aluminum (total)	3.3	2.8	4	25
Arsenic (diss)	<0.02	<0.02	na	na
Arsenic (total)	<0.02	<0.02	0.25	0
Barium (diss)	<0.05	<0.05	1	0
Cadmium (diss)	<0.0005-0.0018	<0.0005-0.001	0.01	0
Cadmium (total)	0.0023	0.0016	na	na
Chromium (diss)	0.17	<0.05-0.2	na	na
Chromium (total)	0.17	0.15	0.3	16.7
Cobalt (diss)	<0.05	<0.05	0.5	0
Cobalt (total)	<0.05	<0.05	na	na
Copper (diss)	0.04	0.05	0.5	0
Copper (total)	0.2	0.16	na	na
Iron (diss)	1.16	0.99	1	33.3
Iron (total)	3.23	2.7	na	na
Lead (diss)	0.014	0.017	na	na
Lead (total)	0.1	0.059	0.1	0
Manganese (diss)	0.06	0.06	0.5	0
Manganese (total)	0.1	0.09	na	na
Mercury (total)	0.0006	<0.0005-0.0012	0.002	0
Molybdenum (diss)	<0.03	<0.03	na	na
Molybdenum (total)	<0.03	<0.03	0.5	0
Nickel (diss)	0.14	0.12	0.5	0
Nickel (total)	0.18	0.15	na	na
Selenium (diss)	<0.025	<0.025	na	na
Selenium (total)	<0.025	<0.025	0.1	0
Silver (diss)	<0.02	<0.02	na	na
Silver (total)	<0.02	<0.02	1	0
Tin (diss)	<1	<1	na	na
Tin (total)	<1	<1	10	0
Zinc (diss)	0.16	0.15	na	na
Zinc (total)	0.47	0.33	5	0
Toxicity	nd	<56 - >100*	75	66.7

NOTES:
Based on GVRD monthly analysis data.
Units are mg/L except pH, and Toxicity which is expressed as 96hr LC50 %v/v.
Toxicity tests done by B.C. Research.
Range given where average indeterminate (see below)..
* grab sample, all others composited proportional to flow over 24 hours.
na not applicable
nd no data
Calculation of Average Values:
- Average less than detection limit if most individual results were less than detection limit with statistically insignificant number near detection limit.
- Average indeterminate if individual values equally distributed between less than values and finite values.
- Average calculated if most individual values were finite with statistically insignificant number below the detection limit, these were assigned the detection limit value and used in the calculation.

(source: GVRD, 1988c:Table 5.5, 5.7, 5.8)

Table 8.5 SEWAGE TREATMENT PLANT CONTAMINANT LOADINGS, 1985

Parameter (kg/day)	Iona	Annacis	Lulu
Discharge (m^3/day)	466,789	291,791	41,230
Biological oxygen demand	37,810	45,519	5,731
Suspended solids	26,607	20,717	2,639
Kjeldahl nitrogen	7,469	7,587	1,237
Ammonia	4,108	4,669	817
Fluoride	75	44	5.8
MBAS	420	554	87
Sulphate	12,137	7,878	1,484
Calcium carbonate	33,609	30,930	4,535
pH	3,361	2,013	284
Phosphorus (diss)	840	905	136
Phosphorus (total)	1,354	1,314	219
Oil and Grease	7,469	8,462	1,278
Phenol	14	15	1.6
Boron (diss)	75	85	13
Aluminum (diss)	bdl	bdl	33
Aluminum (total)	ai	233	115
Cadmium (tot)	ai	ai	0.07
Chromium (total)	bdl	bdl	6.2
Copper (diss)	19	15	2.1
Copper (total)	47	41	6.6
Iron (diss)	135	236	41
Iron (total)	415	525	111
Lead (diss)	ai	3.8	0.7
Lead (total)	20	12	2.4
Manganese (diss)	23	20	2.5
Manganese (total)	28	29	3.7
Nickel (diss)	bdl	ai	4.9
Nickel (total)	bdl	ai	6.2
Zinc (diss)	37	29	6.2
Zinc (total)	56	50	14

NOTES:
Derived by multiplying finite effluent concentrations from Tables 8.1, 8.2, and 8.3 by the STP average reported flows for 1987.
ai: average indeterminate
bdl: below detection limit
Loadings for other contaminants listed in Tables 8.1, 8.2, and 8.3 are uncertain because tests are not sensitive enough to determine a finite average value for the contaminant concentration.

Table 8.6 PRIVATE MUNICIPAL PERMITS

No.	Name	Type	Reach	Flow (m^3/day) Permitted	Reported
PE0002	St George Holdings	Municipal	MA	45.5	43
PE0372	Annsep Properties Ltd	Municipal	MA	30	37
PE0441	Kenrae Enterprises	Marina	MS	273	0
PE2393	B.C Ferries	Municipal	SRB	54.5	12
PE3154	Swiftsure Towing	Municipal	MS	1.14	nd
PE5230	Farrell Estates Ltd	Marina	MA	227	6
PE6286	Strata Plan NW-2245	Marina	MA	34	nd
PE6375	Riverbank Village	Marina	MA	6.8	3
PE7945	Riversbend Village	Municipal	MA	22.3	0
PE8424	Primex Forest Prds.	Municipal	MA	3.8	nd
PE8436	Wes Del Marina	Marina	MA	21.6	nd

nd no data (Source: WMB Files)

Table 8.7 SEWER USE BYLAW STATUS OF FREMP AREA MUNICIPALITIES

Municipality	Joined GVS&DD	Bylaw No	Enacted	Last Amdt	1971 Reg	Source Control	Enforcement Program
Burnaby	Mar 4, 1914	4247	1961	1978	Policy	I	
Coquitlam	Oct 15, 1956	929	1959		Policy		
Delta	Jan 1, 1971	3583	1982			I,S	L
Langley Township	Jan 1, 1987	2438	1987			I,S	L,S
Maple Ridge*	Jan 1, 1981	691	196-		Policy		
New Westminster	Jan 1, 1970	4524	1971		Bylaw		
Pitt Meadows*	Jan 1, 1981						
Port Coquitlam	Jan 1, 1970	1091	1971		Policy		
Richmond	Sep 1, 1965				Policy		L
Surrey	Jan 1, 1965	2240	1964	1987	Bylaw		S
Vancouver	Mar 4, 1914	5320	1980	1985		I,S	L
White Rock**	Jan 1, 1975	396	1970	1984			

NOTES:
* Member of Dewdney-Alouette Regional District
** Has policy of not allowing industry to locate within boundaries
1971 Regs: GVS&DD 1971 Regulations:
policy: Unwritten policy to follow regulations
bylaw: Adopted into bylaw
Source control program:
I Inspection
S Sampling
Enforcement program:
L Letter of violation sent
S Surcharge system in place

(Source: GVRD, 1988d:Tables 1.1, 2.4; Appendix F, Table 3.1)

Appendix 9 Industrial Effluents

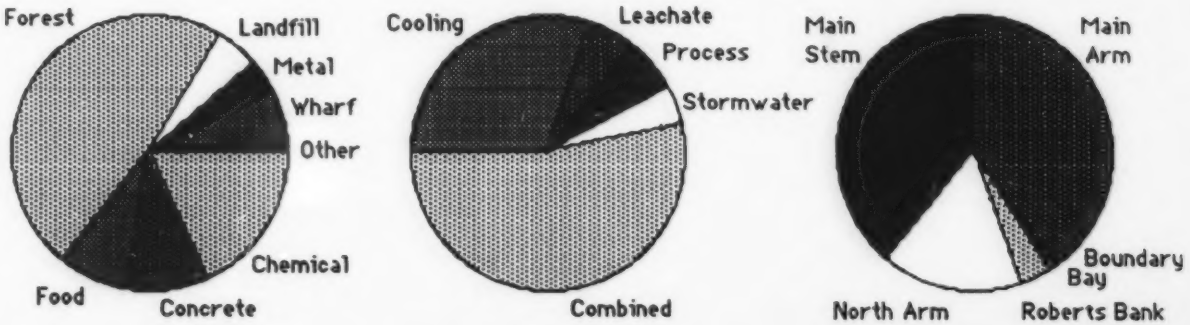
9.1 Introduction:

Industrial effluents are point source liquid discharges that are direct to the estuary rather than to sewer systems (many major discharges go to sewer, and are the industrial component discussed in Appendix 8). Discharge types include process water, cooling water, potentially contaminated site runoff, sewage, or a combination of these. Process water is defined as water used in the manufacturing process, or water that comes into contact with materials used. Cooling water need not contact materials used, but may pick up contaminants from pipes, containers, or water treatment chemicals, as well as increase in temperature. Stormwater, which may become contaminated through contact with stored materials, may be discharged separately as site runoff. A number of waste streams may join as one combined flow prior to discharge to the river. Regulation is through permit from the Waste Management Branch of the Ministry of Environment, which sets maximum flows and specifies maximum concentrations for some contaminants in the discharges according to specified Pollution Control Objectives and expected environmental impact. Sources include chemical factories, concrete plants, food processing facilities, forest product mills, metal finishing and fabricating plants, petroleum distilleries, and port facilities.

9.2 Area Characteristics and Flows:

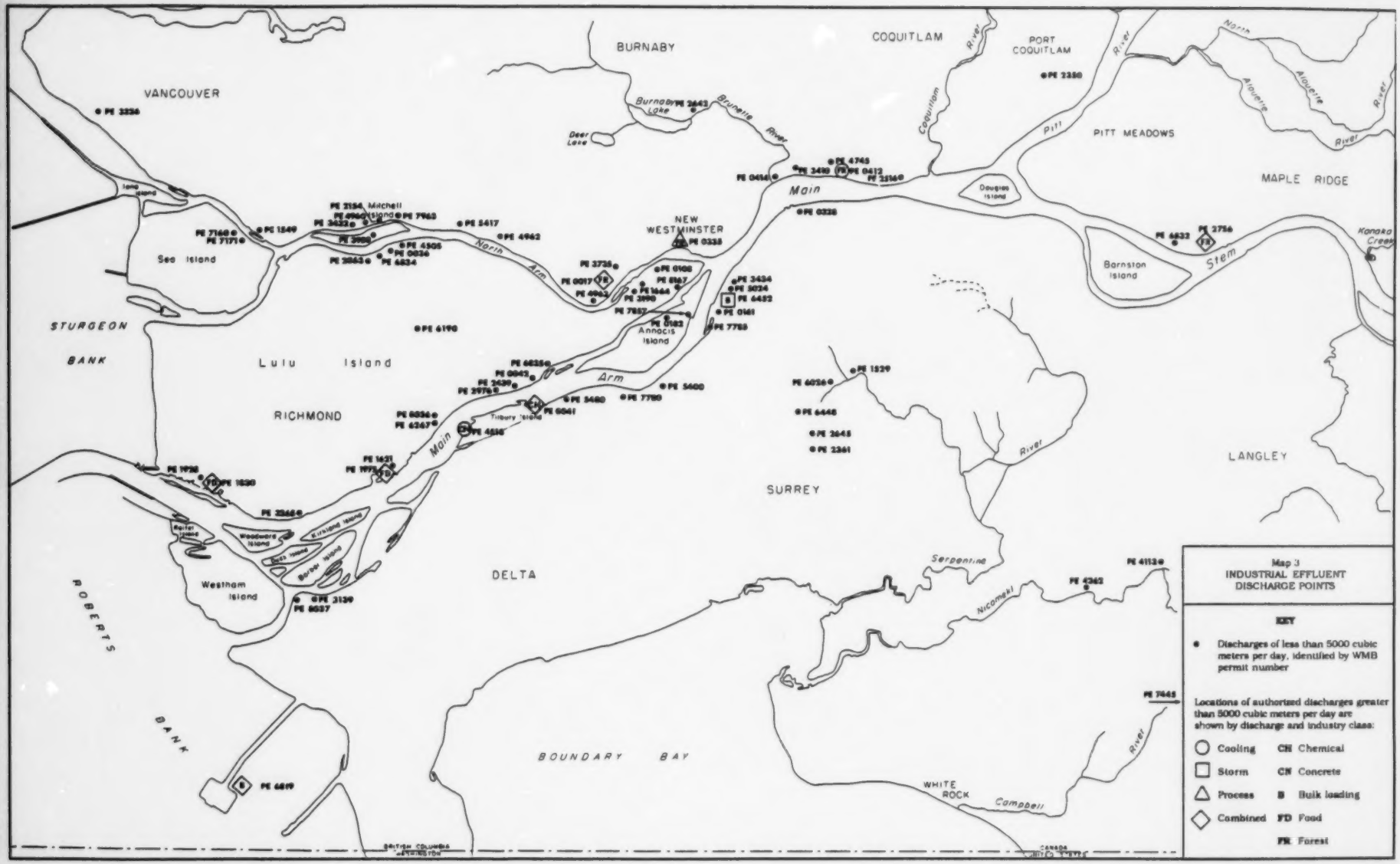
A total of 69 permits allowing total flows of 265,475 m^3/day exist for the Fraser estuary (Tables 9.1 - 9.4, Map 3). Of this authorized flow, 39% is to the Main Arm from 26 permits, 39% is to the Main Stem from 11 permits, 16% is to the North Arm from 23 permits, and 1% to Boundary Bay tributaries from 8 permits. The remaining permit is for a 10,018 m^3/day combined flow from Westshore Terminals to Roberts Bank. Discharge types are predominantly combined and cooling water flows, which make up 54% and 30% of the total respectively. Other flows consist of process water at 7%, leachates 5%, and stormwater 4% (Figure 9.1).

Figure 9.1 AUTHORIZED INDUSTRIAL DISCHARGES TO SURFACE WATERS



(Source: Waste Mangement Branch files)

Actual flows are usually less than permitted flows, but are difficult to quantify as few permit holders reliably monitor their flows. Eighteen permit holders representing 198,425 m^3/day, or 75% of authorized discharge, reported flow data for 1987. For these, actual flows were 90,656 m^3/day, or 46% of the authorized levels. Interpolation of this proportion to all permits is questionable due to the wide range of discharge levels.



Map 3
INDUSTRIAL EFFLUENT DISCHARGE POINTS

KEY

- Discharges of less than 5000 cubic meters per day, identified by WMB permit number

Locations of authorized discharges greater than 5000 cubic meters per day are shown by discharge and industry class:

○	Cooling	CH	Chemical
□	Storm	CN	Concrete
△	Process	B	Bulk loading
◇	Combined	FD	Food
		FR	Forest

A characteristic of industrial effluent flows is the dominance of a small number of industries. Of the 69 permits, 13 have permitted flows greater than 5,000 m^3/day, totalling 90% of authorized flows to the Fraser estuary, or 238,260 m^3/day (Table 9.5). Of the combined flows, Chatterton Petrochemicals is authorized to discharge 43,200 m^3/day into the Main Arm, and Fletcher Challenge 45,000 m^3/day into the Main Stem at Port Hammond; 62% of all combined flows are from these two discharges. Other significant combined flows are from B.C. Packers and Ocean Fish to the Main Arm, and Paperboard Industries to the North Arm. Cooling water flows are dominated by Fletcher Challenge, with 55,500 m^3/day into the Main Stem at Fraser Mills, 67% of all cooling discharges. Process water and stormwater flows also show this dominance pattern. Even if all industrial discharges to the estuary had similar contaminant concentration characteristics, the majority of loadings would be from these few significant flows. Effective use of scarce management resources suggests that action items should be centered on these dischargers.

9.3 Loadings:

The first comprehensive examination of industrial effluent loadings was performed by Swain (1980), as part of the FRES Phase 1 program. Swain reviewed industrial wastewater effluents for the period 1970 to 1978 for seven industrial sectors, essentially describing discharges permit by permit. Some loading values were based on very few data, and he cautioned that extrapolations were speculative and subject to error. Nonetheless, a summary of loadings for all industrial sectors was provided (Table 9.6). The majority of contaminant loadings were from the food industry for the Main Arm, and the forest industry for the North Arm and the Main Stem. BOD5 was an exception in the Main Stem where the food industry was the dominant source of loadings. Metal loadings of copper, iron, lead, nickel, and zinc were also summarized. North Arm metal loading totals were from the forest and metal sectors, and were greater than those for the Main Arm except for iron. No Main Stem metal loadings were reported.

In 1984, a recommended approach to Fraser River estuary monitoring listed 13 operations having the greatest potential for discharging large quantities of contaminants of concern (Working Committee on Fraser River Monitoring, 1984). This preliminary list (Table 9.7) was the basis for the 1986 effluent monitoring program (Supervisory Coordinating Committee, 1987) which examined 9 industries (Table 9.8). The purpose of the 1986 monitoring program was to examine major discharges for contaminants of concern which may not have been previously identified as entering the estuary. The sites were investigated for discharge flows and contaminant concentrations. Some loading estimates are given in the individual technical reports, summarized in the summary report as: Titan Steel and Wire 0.6 - 2.3 kg/day of iron, 0.4 - 1.4 kg/day of zinc, 0.4 - 0.6 kg/day of phosphorus, and up to 1.2 kg/day of boron; Western Canada Steel 19 kg/day of iron; Paperboard 0.8 kg/day of phthalates, 26.9 - 42.6 kg/day of aluminum, and 1.71 - 3.19 kg/day of zinc; and Scott Paper 73.5 kg/day of aluminum and 29.1 kg/day of iron. Conclusions were that all four metal finishing and fabricating plants occasionally had acutely toxic effluents. Paperboard and occasionally Scott Paper also had acutely toxic effluents. LaFarge and Chatterton had non-acutely toxic effluents, and chlorophenols were found in the effluents from Doman and Paperboard. Recommendations were made regarding monitoring procedures.

The Provincial Waste Management Branch 1987 data has been analyzed to determine contaminant loadings for the industries with authorized discharges to surface waters (Tables 9.9 and 9.10). Most contaminant loadings, as is the case for flows, originate from a few industries. However, large volume discharges do not necessarily contribute large contaminant loadings as they may consist of relatively uncontaminated cooling water discharges.

Nineteen companies reported contaminant discharges for 1987. NFR loadings are most common, totalling 7,226 kg/day from 13 companies, primarily from Paperboard, B.C.

Packers, and Genstar. Loadings of oil and grease totaled 342 kg/day from 11 companies, predominantly from B.C. Packers, Genstar, and B.C. Forest Products. BOD5 discharges totaled 4,739 kg/day from 5 companies, 92% from Paperboard Industries. Nutrient loadings were contributed by 3 permit holders (Table 9.9). Not included on this table are boron loadings of 0.2 kg/day from Western Canada Steel, and 0.27 kg/day of sulfate from Associated Foundry.

Recorded priority contaminant loadings include chlorophenols and 15 metals. In spite of much recent interest in chlorophenols few chlorophenol data are to be found in WMB files. Loading reports are for up to 4 kg/day of tetrachlorophenol from Belkin (now Paperboard Industries), with other loadings reported by Domtar (Table 9.10). Three metal finishing and fabricating companies, two forest sector, two chemical, and a petroleum sector company reported metal loading. Five of these companies are located on the North Arm. Loadings were skewed significantly by the Western Canadian Steel plant which discharged 13.5 kg/day of iron, 8.1 kg of magnesium, 3.8 kg of manganese, 2.4 kg of lead, 2.3 kg of cobalt, 1.2 kg of barium and nickel, and between 0.1 and 1 kg of aluminum, cadmium, copper, molybdenum, and zinc. For other permits, metal loadings ranged between 0.9 kg/day for iron, down to less than 0.0001 kg/day for several metals. Most prevalent were iron, copper, lead, manganese, and zinc. Most discharges contain trace concentrations only.

These loading values are based on WMB permit information. Permit holders are responsible for regularly reporting sampling results. The sampling frequency varies from daily to annually depending on type, amount, and impacts of the contaminants. Permit requirements are monitored by conducting audit-type samplings of effluent. Loadings reported in Tables 9.9 and 9.10 are derived from either permittee reported or WMB reported concentration figures multiplied by the average flow, if reported by the permit holder, or by the maximum permitted flow. There is usually no clear indication how actual flows compare to permit levels. Gaps in the tables indicate either no data or an absence of contaminants. Some permits have since been cancelled, others, notably Western Canada Steel, have been closed or are dormant. Genstar is now Tilbury Cement, B.C. Forest Products is now owned by Fletcher Challenge Canada.

9.4 Issues:

Issues identified for industrial effluents include adequacy of the data base, degradation of the North Arm, toxicity of effluents, permit noncompliance, and unauthorized discharges.

While a fair amount of data exists regarding industrial effluent contaminant concentrations, no clear idea of total loadings, areas of greatest impact, or significance emerges. Previous data discussions include Swain (1980), Swain and Holms (1985), and the Supervisory Coordinating Committee (1987). These are basically permit by permit reviews with no extrapolation to the whole area. An attempt is made in this report to estimate total loadings using WMB file data for 1987. However, the reliability of the derived figures is questionable due to lack of good flow figures to go along with contaminant concentrations, and lack of concentration figures for many contaminants. For instance, the 1986 effluent monitoring program (Supervisory Coordinating Committee, 1987) reported metal loadings for Belkin (Paperboard Industries), Titan Steel and Wire, Scott Paper, and LaFarge Cement, but these are not reported in the 1987 WMB files used for the above analysis.

Industrial effluent data indicate a fair proportion of flows and loadings to the North Arm. Natural river flows in the North Arm are less than 20% of those in the Main Arm, mixing and dilution potential is correspondingly lower. North Arm water quality is the most degraded of the three reaches (Coastline, 1987) and industrial effluents are a main contributor of contaminants. Reducing industrial effluent is a necessary step to improve water quality in the North Arm.

The issue of toxicity in the initial dilution zone was discussed with reference to the STPs in Appendix 8. This concern also applies to industrial discharges, with the additional concerns regarding adjacent outfalls. Overlapping IDZs or additive effects of a series of outfalls may have effects on chronic toxicity if not acute toxicity. Many industries treat their effluents, some have secondary treatment facilities. There are mixed views on whether some or all industrial discharges should be connected to sewer. There are some problems associated with the small size of most treatment plants, but effluent quality from most industrial discharges is generally as good or better than that from STPs. Anti-sapstain contaminated industrial site stormwater inputs are a primary source of toxic plumes in the estuary.

About 85% of permits administered by WMB are in compliance for all parameters. Noncompliance is from lack of reporting or higher than authorized contaminant concentrations. Enforcement of permit requirements is an issue discussed in Appendix 6. Noncompliance with the Waste Management Act in terms of unauthorized discharges also occurs and was the focus of the Fraser River Task Force (1980). There is presently no clear idea of the number of these unauthorized discharges nor of the impact they have on the quality of the Fraser. The 1986 effluent monitoring program (Supervisory Coordinating Committee, 1987) reported that Noranda (now Wolverine Pipe) and neighboring Davis Wire had unauthorized discharges. Wolverine Pipe has since obtained permit PE7857 effective May 1988, and Davis Wire now discharges to sewer.

9.5 Initiatives:

Many industries periodically upgrade their pollution control equipment. Titan Steel undertook a plant upgrading in 1987 that resulted in some improvement in their waste streams. Source control measures and treatment equipment required to fulfill permit requirements were installed at Wolverine Pipe, leading to reduced effluent loadings. Paperboard Industries has installed secondary treatment works which came online during 1989 and have resulted in effluent concentrations that meet or exceed level A of the provincial pollution control objectives.

A contract was let by MOE to investigate the five major metal finishing and fabricating plants: Wolverine Pipe, Titan Steel and Wire, Kennametal, Tree Island Steel, and Western Canada Steel. The contractor examined the company's waste management objectives, waste disposal methods, environmental impacts, special waste generation, and disposal procedures. No new monitoring was performed as current data was used. A similar Fraser River Fish Plant Survey encompassing Ocean Fisheries, B.C. Packers, and Long Beach Shellfish was performed by WMB staff during 1987 (Moore, 1987).

Environmental Protection continues to investigate chlorophenol use as a wood preservative by forest companies. A 1984 Code of Good Practice set standards for technology use, and recommended practices such as covered storage areas. Compliance with the Code is periodically surveyed, most recently in 1984 (Wilson and Liu, 1986). A revised Code of Good Practice for wood protection chemical use was negotiated between federal, provincial, and industry representatives, and an Anti-Sapstain Chemical Waste Control Regulation under the Waste Management Act became effective November 1, 1989. This regulation puts strict limits on the quantity of chlorophenols and TCMTB allowed in stormwater runoff. Most operations have converted from chlorophenols to alternative antisapstain chemicals.

The comprehensive studies of the GVRD LWMP mention permitted discharges, industrial effluents covered under WMB permits, but do not evaluate them. Data contained in WMB files is difficult to extract and analyse.

9.6 Remedies:

A remedy for the first issue discussed above, database inadequacy, would address data gaps and organize information in agency files so as to be easily retrieved and analyzed. An accurate knowledge of flows from all discharges is needed, overall loading estimates for the Fraser estuary are unreliable otherwise. Once a good idea of overall significance and local impacts of industrial effluents is known, various treatment options could be investigated. Information from agency files should be used for a periodic report on the State of the Fraser Estuary. Trends in levels of toxic substances and pollutants could then be evaluated. Interpretation of the data will need to be coordinated with the Standing Committee on the Fraser River Water Quality Plan.

Remedies to address North Arm degradation are similar to those discussed below. The North Fraser Harbour Environmental Management Plan (NFHC, 1988) addresses water quality issues. Activities in that plan and the Waste Management Activity Program should be coordinated.

Options for reducing contaminant loadings or effluent toxicity from industrial discharges include connection to sewer, treatment, discharge modifications, and administrative changes. Some or all industrial discharges can be connected to sewer. However, primary treatment now performed at the STPs does not remove high proportions of metals or organics. Theoretical primary treatment removal efficiencies are 6 or 7% for cadmium and nickel, 16 to 26% for chromium, copper, lead, mercury, manganese, and zinc, and 40% for iron. Removal efficiencies for organics are not much above zero (GVRD, 1988c; 1988d). A determination of impacts on STP operation and effluent quality would be required as part of a sewer connection program, and source control may be needed. Centralized treatment plants serving selected industries, permit holders, or discrete areas could be provided. Sewage from an industrial area such as Mitchell Island, which is already sewered, could be diverted to a new treatment plant specifically designed to deal with the characteristic contaminant load.

Infiltration ponds could be used as alternate liquid waste disposal methods. Contaminants associated with sludges might be safely landfilled rather than discharged to the river, though some contaminated sludges from industry may be classified as special wastes. Some contaminants in waters drained to infiltration ponds might be inactivated or destroyed by soil organisms or ion exchange processes before reaching the river.

Toxicity problems can be addressed by improved discharge systems, dilution, or use of alternate water supplies. While these types of options may be desirable in conjunction with treatment options, or where no other option exists, they are viewed with disapproval by government officials as they do not reduce contaminant loadings. Many discharges are currently to ditches or near-shore outfalls. Submerged outfalls equipped with diffuser systems more effectively disperse contaminants throughout receiving waters. Where these already exist, improved diffuser riser and port structures might be possible. Smaller port openings and horizontal rather than vertical orientations assist in IDZ mixing. In-pipe dilution by combining flows or by taking water from the river for dilution purposes will also address toxicity problems. Use of hard well water could help alleviate toxicity problems associated with certain process or cooling water streams with metals concentrations. Relatively uncontaminated cooling water streams could be combined with process waters to reduce overall toxicity before discharge. Impacts of industrial effluents on specific areas could be alleviated by moving the discharge to a different area which has more assimilative capacity. If an Annacis STP deep sea outfall is constructed, industrial discharges could be connected to it. The outfall could be routed along the North Arm to collect higher impact discharges there. Alternately, North Arm discharges could be rerouted into the Main Arm where assimilative capacity is greater. Potential deep sea or Main Arm impacts would need to be evaluated before either of these options is undertaken. However, as most concerns over industrial discharges are for chronic and bioaccumulation effects, and as dilution options do

not address contaminant reduction, these options are not preferred or endorsed by the regulating agencies.

An administrative option to encourage good waste management practices would be to overhaul permit fees to include effluent quality criteria and incentives to reduce contaminant loads or pursue other waste disposal methods such as recycling. The Waste Management Fees Regulation of the Waste Management Act is based on industry type and production capacity. However, the volume and quality of a permitted effluent stream may bear little relation to the production capacity of individual industries. Restructuring permit fee regulations to include financial incentives would result in pollution abatement. These could take the form of surcharges for various levels of contamination up to the authorized limit, or credits for reduction below the permit level. Explicit timetables for permit upgrading to more stringent standards could also be provided. Waste management compliance and upgrading schedules should be developed based on attaining and maintaining ambient water quality objectives, or higher standards where these prove available and practical.

Other methods of setting quality standards for a permitted discharge could be explored. The current criminal law model under which regulatory processes such as the WMA operates have several limitations. A contract model of pollution control as described by Barton et al. (1984) should be explored as a means to achieve pollution control. Regulatory methods focusing on technologically achievable or practical effluent standards in association with ambient standards mechanisms should be investigated.

A mechanism for locating unauthorized discharges and bringing them under permit needs to be established This would be part of a surveillance, compliance, and enforcement strategy for the Fraser which should be developed jointly by FREMP member agencies. Enforcement of permit noncompliance should also be a priority, see Appendix 6.

9.7 References Cited

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Table 9.1 AUTHORIZED INDUSTRIAL DISCHARGES TO SURFACE WATERS, BOUNDARY BAY

Permit #	Name	Industry Type	Discharge Type	Maximum Discharge (m^3/day)
PE1529	Associated Foundry	Metal	Combined	91
PE2361	Canadian Plastic Pak	Chemical	Cooling	390
PE2645	Ellehammer Industries	Chemical	Cooling	55
PE4262	PetroCan	Petroleum	Stormwater	55
PE4413	Masonville Plastics	Chemical	Cooling	109
PE6026	B.C. Hydro	Energy	Stormwater	1,250
PE6448	Harcros Chemicals Canada	Chemical	Combined	250
PE7445	Hugh G. Roy	Food	Process	1,040
TOTAL				3,240

Table 9.2 AUTHORIZED INDUSTRIAL DISCHARGES TO SURFACE WATERS, MAIN ARM

Permit #	Name	Industry Type	Discharge Type	Maximum Discharge (m^3/day)
PE0041	Chatterton Petrochemical	Chemical	Combined	43,200
PE0042	Canada Cement Lafarge	Concrete	Combined	6,360
PE0161	Titan Steel and Wire	Metal	Cooling	4,650
PE0182	Fletcher Challenge	Forest	Fire quench	27
PE1621	Fraser Wharves	Wharf	Process	80
PE1830	B.C. Packers Ltd	Food	Combined	8,541
PE1928	Imperial Oil Ltd	Petroleum	Stormwater	55
PE1975	Ocean Fisheries	Food	Combined	7,249
PE2439	Canada Cement Lafarge	Concrete	Combined	275
PE2976	ConForce Structures	Concrete	Combined	229
PE3139	Long Beach Shellfish	Food	Process	45.5
PE3265	Canfor Ltd	Forest	Cooling	91
PE4513	Tilbury Cement Ltd	Concrete	Cooling	18,200
PE5024	Fraser Surrey Dock	Wharf	Cooling	2.75
PE5400	Richmond Canning	Food	Combined	1,740
PE5480	Vito Steel Boat and Barge	Metal	Sewage	2.25
PE6190	Ocean Spray Ltd.	Food	Process	750
PE6276	Fraser River Harbour Com.	Landfill	Leachate	10,000
PE6452	Fraser Surrey Dock	Wharf	Stormwater	7,500
PE6835	Supercrete Precast Ltd	Concrete	Stormwater	35
PE7780	Vancouver Energy	Forest	Combined	2
PE7785	Shearer Seafood	Food	Process	4.6
PE7857	Wolverine Tube	Metal	Combined	3,000
PE8036	Richmond Landfill	Landfill	Leachate	2,000
PE8037	Canadian Holographic Dev.	Chemical	Process	2
PE8167	New West Net Co.	Food	Process	22.7
PE6819	Westshore Terminals	Wharf	Combined	10,018*
TOTAL				114,064

* Discharges to Sturgeon Bank. Discharge not included in Main Arm total.

Table 9.3 AUTHORIZED INDUSTRIAL DISCHARGES TO SURFACE WATERS, MAIN STEM

Permit #	Name	Industry Type	Discharge Type	Maximum Discharge (m^3/day)
PE0328	Mill and Timber Products	Forest	Sewage	13.6
PE0412	Fletcher Challenge	Forest	Cooling	55,500
PE0414	Lamford Forest Products*	Forest	Combined	80
PE2350	Kennametal	Chemical	Cooling	114
PE2516	Columbia Bitulithic	Chemical	Stormwater	1,220
PE2642	Continental Can Co	Metal	Cooling	200
PE2756	Fletcher Challenge	Forest	Combined	45,000
PE3410	Domtar Inc	Chemical	Cooling	465
PE3434	Weldwood	Forest	Combined	194
PE4745	Westfair Properties	Landfill	Leachate	1,500
PE6832	Bay Lumber	Forest	Cooling	275
TOTAL				104,562

* Closed as of January 23, 1990

Table 9.4 AUTHORIZED INDUSTRIAL DISCHARGES TO SURFACE WATERS, NORTH ARM

Permit #	Name	Industry Type	Discharge Type	Maximum Discharge (m^3/day)
PE0017	Paperboard Industries	Forest	Combined	11,400
PE0036	Thomas J. Lipton Inc	Food	Cooling	373
PE0108	MacMillan Bathurst	Forest	Cooling	23
PE0335	Scott Paper Inc	Forest	Process	12,650
PE1549	The Borden Co Ltd	Chemical	Cooling	955
PE1664	MacMillan Bloedel	Forest	Process	237
PE2063	Nestle Enterprises	Food	Combined	370
PE2154	Weldwood K	Forest	Combined	490
PE3190	Tree Island Steel	Metal	Combined	1,500
PE3326	B.C. Research	Misc.	Process	*
PE3432	Canada Cement Lafarge	Concrete	Combined	470
PE3735	Domtar Inc	Chemical	Cooling	940
PE3950	Terminal Forest Products	Forest	Combined	7.35
PE4505	BC Coast Vegetables	Food	Process	1,090
PE4960	International Forest Prds	Forest	Process	220
PE4962	Hilinex Packaging Inc	Forest	Combined	145
PE4963	Paperboard Industries	Forest	Combined	73
PE5417	MacMillan Bloedel	Forest	Combined	136
PE6834	Alcan Aluminum Ltd	Metal	Cooling	35
PE7160	Consolidated Aviation	Petroleum	Stormwater	415
PE7171	Trans Mountain Pipeline	Petroleum	Stormwater	212
PE7321	Chevron Canada Ltd	Petroleum	Stormwater	60
PE7963	Moore Clarke	Food	Process	1,360
TOTAL				33,161

* 1,320 once/month; 2,590 once/year

Table 9.5 SIGNIFICANT FLOWS: Permits with permitted flows greater than 5,000 m^3/day

Name	Permit #	Industry Type	Discharge Type	Authorized (m^3/day)	Actual (m^3/day)
MAIN ARM					
Chatterton	PE0041	Chemical	Combined	43,200	40,744
Canada Lafarge	PE0042	Concrete	Combined	6,360	5075
Tilbury Cement	PE4513	Concrete	Cooling	18,200	9,323
Westshore Term	PE6819	Wharf	Combined	10,000	158
BC Packers	PE1830	Food	Combined	8,086	na
Ocean Fish	PE1975	Food	Combined	7,240	na
FRHC	PE6276	Landfill	Leachate	10,000	na
Titan Steel and Wire	PE0161	Metal	Cooling	4650	2773
MAIN STEM					
Fletcher Challenge	PE0412	Forest	Cooling	55,500	1552
Fletcher Challenge	PE2756	Forest	Combined	45,000	21,000
NORTH ARM					
Scott Paper	PE0335	Forest	Process	12,650	na
Paperboard Ind	PE0017	Forest	Combined	11,400	9,562
Fraser Surrey	PE6452	Wharf	Stormwater	7,500	na
TOTAL				239,786	90,187

Notes:
Authorized: Maximum flows permitted by permit.
Actual: Flow reported by permit holder, 1987 data
na Not available.

(Source: WMB files)

Table 9.6 INDUSTRIAL LOADINGS SUMMARIES FOR 1979

Industrial Sector	Suspended Solids			BOD_5		
	MS	NA	MA	MS	NA	MA
Forest	5,263	23,700	-	7	4,972	-
Food	98	455	3,550	796	347	17,667
Metal	-	1150	292	-	-	-
Cement	-	100	1,515	-	-	26
Municipal	4	6	9	6	3	10
Miscellaneous	67	-	23,831	24	-	-
Total	5432	25,411	29,197	833	5,322	17,703
TOTAL		60,040			23,858	

Industrial Sector	Total Phosphorus			Total Nitrogen		
	MS	NA	MA	MS	NA	MA
Forest	2	2.5	-	15.8	38.2	-
Food	-	0.5	16.8	-	1.9	191.9
Metal	-	0.8	-	-	0.5	-
Cement	-	-	-	-	-	-
Municipal	0.6	0.1	0.2	4.4	0.1	1.8
Miscellaneous	-	-	5.3	-	-	17.8
Total	26	39	22.3	202	407	211.5
TOTAL		28.8			272.4	

Sector	Copper	Iron	Lead	Nickel	Zinc
NA Forest	0.9	15.7	1.8	0.3	53
NA Metal	1.2	105	4.8	-	89.5
North Arm Total	2.1	120.7	6.6	0.3	142.7
Main Arm Total	0.1	132.5	0.4	-	0.2
TOTAL	2.2	253.2	7	0.3	142.9

Notes:
Values in kg/day
MS: Main Stem; NA: North Arm; MA: Main Arm

(Source: Swain, 1980:table 41, p195)

Table 9.7 HIGH PRIORITY INDUSTRIAL DISCHARGERS, 1984

PE #	Name	Reach	Industry type	Concern
17	Belkin Packaging[1]	NA	Forest Products	Toxicity, CPs, BOD
42	LaFarge Cement	MA	Cement	NFR, COD, pH
161	Titan Wire and Steel	MA	Metal Finishing	Metals, toxicity
335	Scott Paper	NA	Forest Products	COD, Al, Fe
412	Crown Zellerbach, Fraser Mills[2]	MS	Forest Products	BOD, CPs
1549	Borden	NA	Chemical	Toxicity
1664	MacMillan Bloedel, New Westminster	NA	Forest Products	Chlorophenols
1666	MacMillan Bloedel, Canadian White Pine	NA	Forest Products	Chlorophenols
2071	Globe West Products			
2087	Western Canada Steel[3]	NA	Metal Finishing	Metals, toxicity
2756	B.C. Forest Products, Hammond[2]	MS	Forest Products	Chlorophenols
3190	Tree Island Steel	NA	Metal Finishing	Metals, toxicity
4513	Genstar[4]	MA	Cement	NFR, pH

[1] Now Paperboard Industries
[2] Now owned by Fletcher Challenge
[3] Closed as of 1988
[4] Now Tilbury Cement

(Source: Working Committee on Fraser River Estuary Monitoring, 1984)

Table 9.8 INDUSTRIES MONITORIED IN 1986

Rept[1]	PE No.	Name	Reach	Industry Type	Concern
1	161	Titan Steel and Wire	MA	Metal Finishing	Metals, toxicity
2	[2]	Noranda Metal Industries	MA	Metal Finishing	Metals, O&G, toxicity
3	3190	Tree Island Steel	NA	Metal Finishing	Zn, infiltration pond pH
4	2078	Western Canada Steel[3]	NA	Metal Finishing	Metals, landfill leachates
7	17	Belkin Packaging	NA	Forest Products	Toxicity, CPs, PCBs
8	335	Scott Paper	NA	Forest Products	COD, Al, Fe
9	42	LaFarge Cement	MA	Cement	NFR, O&G, pH
10	41	Chatterton Petrochemical	MA	Chemical	Biox system
12	none	Doman Forest Products	MA	Forest Products	Chlorophenols

[1] Technical reports prepared for Supervisory Coordinating Committee
[2] Permit No. PE7857 issued May, 1988, now Wolverine Tube Ltd.
[3] Now closed.
[4] Now Paperboard Industries

(Source: Supervisory Coordinating Committee, 1987)

Table 9.9 CONVENTIONAL POLLUTANT LOADINGS FROM INDUSTRY, 1987

Name	Permit Number	Reach	Industry Type	Discharge Type	Flow (m^3/d)	BOD	Suspended Solids	Oil and Grease	TOC	Ammonia	Phosphorous
Associated Foundry	PE1529	BB	Metal	Process	91		8.2	1.4			
Aviation Fueling	PE7160	NA	Petroleum	Storm	14		0.1				
B.C. Coast Vegetables	PE4505	NA	Food	Process	1,090						
B.C. Packers	PE1830	MA	Food	Combined	8,086			137.5	5,183	105.1	208
Bay Lumber	PE6832	MS	Forest	Cooling	275			0.8			
BCFP	PE2756	MS	Forest	Combined	21,000	210	378	63			
Chatterton	PE0041	MA	Chemical	Combined	40,744		187.4		275.8	4.48	
Crown Forest	PE0412	MS	Forest	Combined	1,200	172	43.6				
Domtar	PE3410	MS	Chemical	Cooling	51			0.2			
Fraser Wharves	PE1621	MA	Wharf	Process	53		0.1		0.5	0.02	
Genstar	PE4513	MA	Concrete	Cooling	9,323		1743	121.2			
Lafarge Cement	PE0042	MA	Concrete	Combined	5,075			14.4			
Lamford Forest Prds.	PE0414	MS	Forest	Combined	80		3.3	0.2			
MacMillan Bloedel	PE1664	NA	Forest	Pro+Cool	124		3.3	2.5			
NEL Products	PE2063	NA	Food	Combined	370			0.4			
Paperboard Industries	PE0017	NA	Forest	Combined	9,562	4,351	4,848				
Richmond Cannery	PE5400	MA	Food	Combined	1.9	0.9	0.4	0.1			
Trans Mtn Pipeline	PE7171	NA	Petroleum	Storm	212						2.54
Western Canada Steel	PE2087	NA	Metal	Storm	45.5		0.9				
Westshore Terminals	PE6819	MA	Wharf	Sewage	158.4	5.2	9.7				
TOTAL						4,739.1	7,226	341.7	5,459.3	109.6	210.54

NOTES:
These are 1987 data, the most recently compiled loading values available. Some name changes, ownership changes, or closures have occurred since this summary was produced: BCFP and Crown Forest are now Fletcher Challenge, Genstar is now Tilbury Cement.
Units in kg/day
Gaps in table indicate no data
Reach: BB Boundary Bay, MA Main Arm, MS Main Stem, NA North Arm
BOD: Biochemical Oxygen Demand
TOC: Total Organic Carbon
Flow is actual if reported, permit maximum if not. See Tables 9.1 - 9.4 for permit maximums.
(Source: WMB files)

Table 9.10 ORGANIC AND METAL LOADINGS FROM INDUSTRY, 1987

Name	Permit Number	Reach	Industry Type	Discharge Type	Flow (m^3/d)	Phenols	PCP	TCP/ TTCP	Aluminum	Arsenic	Barium
Chatterton	PE0041	MA	Chemical	Combined	40,744						
Domtar	PE3410	MS	Chemical	Cooling	51	0.05					0.0001
Terminal	PE3950	NA	Forest	Combined	7.35				0.001		
MacMillan Bloedel	PE1664	NA	Forest	Pro+Cool	124		2.77	4.02/1.24	0.1	<.03	<.03
Tree Island Steel	PE3190	NA	Metal	Combined	525				0.02		<.005
Associated Foundry	PE1529	BB	Metal	Process	91				0.01		0.002
Western Canada Steel	PE2087	NA	Metal	Combined	24,094				0.5		1.2
Trans Mountain	PE7171	NA	Petroleum	Storm	212						
TOTAL						0.05	2.77	5.26	0.63	0.03	1.24

Name	Permit Number	Reach	Industry Type	Discharge Type	Flow (m^3/d)	Cadmium	Cobalt	Chromium	Copper	Iron	Lead
Chatterton	PE0041	MA	Chemical	Combined	40,744		0.6		0.45		
Domtar	PE3410	MS	Chemical	Cooling	51	<.0005	<.005	<.0005	0.0002	0.0002	<0.005
Terminal	PE3950	NA	Forest	Combined	7.35	<.0007	0.0007		0.0001	0.002	<0.0001
MacMillan Bloedel	PE1664	NA	Forest	Pro+Cool	124	<.001	<.01	<.001	0.001	0.001	<.01
Tree Island Steel	PE3190	NA	Metal	Combined	525	0.04	<.05		0.08	<.5	0.3
Associated Foundry	PE1529	BB	Metal	Process	91	<.001	<.01		<.001	0.02	<.009
Western Canada Steel	PE2087	NA	Metal	Combined	24,094	<.23	<2.3		0.7	13.6	<2.4
Trans Mountain	PE7171	NA	PETROL	Storm	212					0.9	
TOTAL						0.27	2.98	0.0015	1.23	15.02	2.72

Name	Permit Number	Reach	Industry Type	Discharge Type	Flow (m^3/d)	Magnesium	Manganese	Molybdenum	Nickel	Vanadium	Zinc
Chatterton	PE0041	MA	Chemical	Combined	40,744						
Domtar	PE3410	MS	Chemical	Cooling	51	0.006	<.0005	<.0005	<.003	<.0005	<.0005
Terminal	PE3950	NA	Forest	Combined	7.35	0.0014	<.0007	<.0007	<.0004	<.0001	<.0001
MacMillan Bloedel	PE1664	NA	Forest	Pro+Cool	124	0.07	0.02	<.001	<.01	<.001	0.004
Tree Island Steel	PE3190	NA	Metal	Combined	525	0.11	0.005	<.005	<.03	<.005	0.27
Associated Foundry	PE1529	BB	Metal	Process	91	0.02	0.002	<.001	<.005	<.001	0.003
Western Canada Steel	PE2087	NA	Metal	Combined	24,094	8.1	3.8	<.24	<1.2		0.7
Trans Mountain	PE7171	NA	Petroleum	Storm	212						
TOTAL						8.31	3.83	0.25	1.25	0.0076	0.98

NOTES:
These are 1987 data, the most recently compiled loading values available. Some name changes, ownership changes, or closures have occurred since this summary was produced. Western Canada Steel is now closed.
Units are kg/day. Blanks in table indicate no data. Totals are overestimated as "less than" designations are ignored.
See text for qualifications of this table.
Reach: BB Boundary Bay, MA Main Arm, MS Main Stem, NA North Arm.
PCP: Pentachlorophenol; TCP: Trichlorophenol; TTCP: Tetrachlorophenol.
Flow is actual if reported, permit maximum if not. See Tables 9.1 - 9.4 for permit maximums.
(Source: WMB files)

Appendix 10 Urban Runoff and Combined Sewer Overflows

10.1 Introduction:

Urban runoff from rooftops, streets, parking lots, and green areas is collected by a network of storm sewers, ditches, and ravines and discharged at numerous points in the estuary. In older parts of the area, combined sewer systems collect sanitary sewage and stormwater in the same pipe. In combined systems, stormwater is passed through the sewage treatment plants for treatment. However, during rainfall events when capacities of sewer lines or plants are exceeded, excess stormwater and sanitary sewage is discharged untreated at a number of combined sewer overflow points. Where separate sanitary and storm sewers exist, sanitary sewage is always treated but all stormwater is discharged untreated to convenient waterbodies. Recent attention has shown that stormwater is not as pure as once thought as it contains significant amounts of NFR, BOD, coliforms, some metals, and some organics.

10.2 Area Characteristics and Flows:

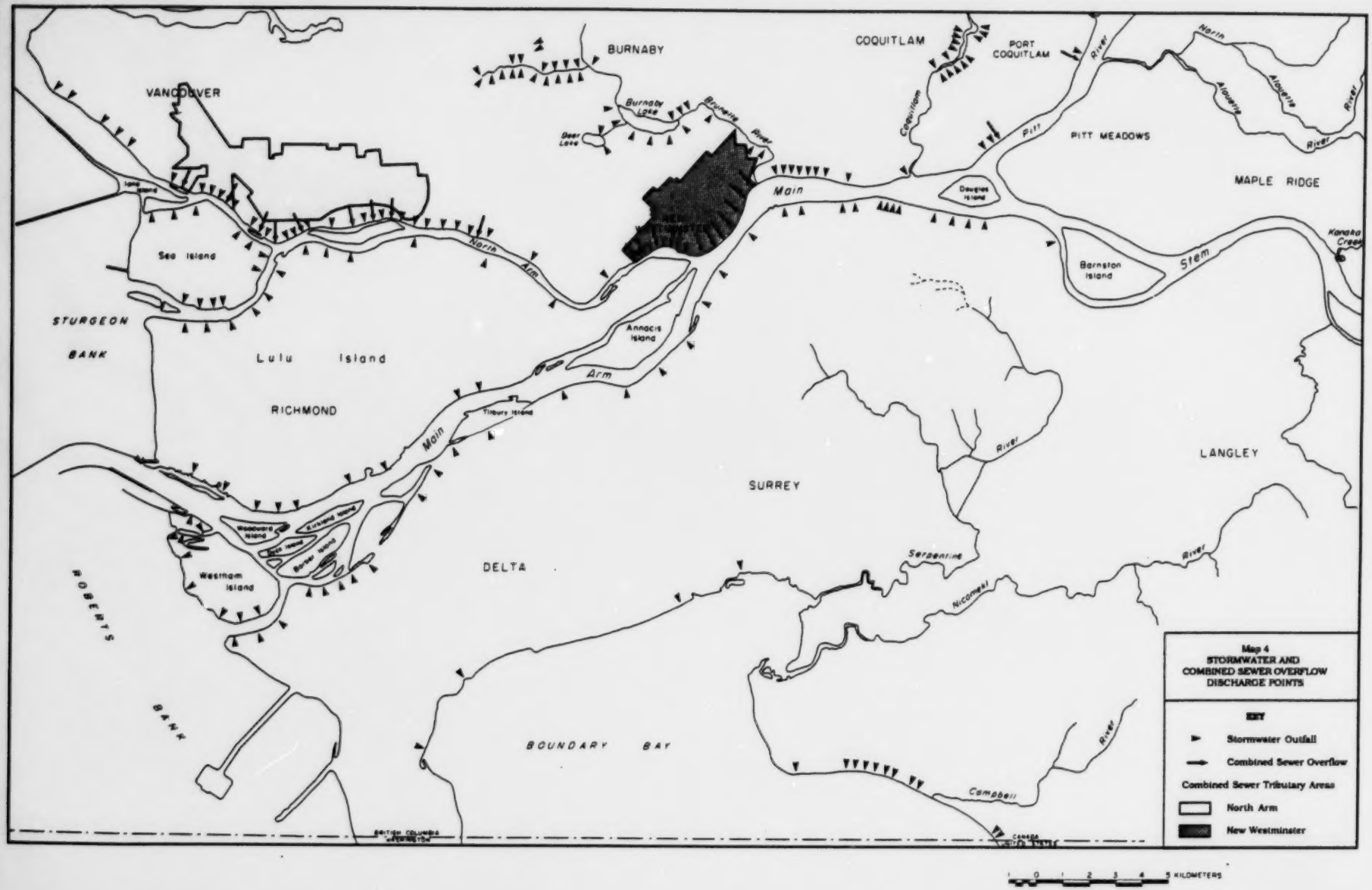
The Greater Vancouver Sewerage and Drainage District has 56,250 ha of sewered area under its jurisdiction, of which 17% or 9,400 ha is combined sewers. Most is in the Vancouver Sewerage Area, where 69% of the 13,200 ha sewered area is combined. Remaining combined sewer networks are in the Westridge area of Burnaby and in the City of New Westminster, the older areas of the Fraser Sewerage Area. All of the Lulu Island Sewerage Area is served by separate sewers (GVRD, 1988a; 1988b).

Approximately 180 pipes or ditches discharging stormwater to the Fraser River and its tributaries in the GVRD have been catalogued (Krahn et al., 1981) (Map 4). These include discharges of rural runoff from agricultural areas (Appendix 11). Most stormwater outfalls have been found to flow even during dry periods, with a total dry weather volume of 356,000 m^3/day during summer months: 30% to the North Arm, 33% to the Main Arm, 25% to the Main Stem, and 12% to Boundary Bay (Clark and Krahn, 1981). Total stormwater flows from urban runoff are estimated as 165 x 10^6 m^3/year or 29% of total flows into the Fraser River system, and 122 x 10^6 m^3/year or 53% of total flows into the Boundary Bay system (GVRD, 1988a, 1988b) (Table 10.1).

On average, there are 154 storm events per year; 39 in summer with a combined duration of 10 days, and 115 in winter with a duration of 53 days (GVRD, 1988a). The capacity of individual sewer system interceptors influences the frequency, volume, and duration of overflows from the various outfalls. On average, combined sewers overflow through 7 outlets to the Main Stem at New Westminster during 95% of annual rainfall events, an average of 151 times per year (GVRD, 1988a). Overflows to the North Arm occur through fourteen outlets during 45% of rainstorms, an average of over 60 times per year (GVRD, 1988a). Total combined sewage overflows are 22 x 10^6 m^3/year or just over 3% of the volume from urban runoff, combined sewer overflows, sewage treatment plants, and industrial discharges (GVRD, 1988a, WMB files) (Table 10.2, Map 4). There are no combined sewage overflows to the Main Arm or to the Boundary Bay system, though tidal reverses and normal river flow conditions can deliver overflow effluents to the Main Arm.

10.3 Loadings:

As part of FRES Phase 1, Ferguson and Hall (1980) summarized the information then available regarding stormwater discharges to the estuary. Following a literature review, they predicted stormwater pollutant loadings to the Fraser estuary by considering average rainfalls, surface runoff coefficients for a variety of land uses, proportion of each land use by municipality, and estimates of contaminant concentrations typical for each land use. Total


VANCOUVER
BURNABY
COQUITLAM
PORT COQUITLAM
PITT MEADOWS
MAPLE RIDGE
Sea Island
STURGEON BANK
Lulu Island
RICHMOND
Annacis Island
Barnston Island
Douglas Island
Westham Island
DELTA
SURREY
LANGLEY
ROBERTS BANK
BOUNDARY BAY
North Arm
Main Arm
Pitt River
Coquitlam River
North Alouette River
Alouette River
Stave River
Serpentine River
Nicomekl River
Campbell River
Hanaka Creek
Burnaby Lake
Deer Lake
Brunette River
Tilbury Island
Map 4
STORMWATER AND COMBINED SEWER OVERFLOW DISCHARGE POINTS
KEY
Stormwater Outfall
Combined Sewer Overflow
Combined Sewer Tributary Areas
North Arm
New Westminster
0 1 2 3 4 5 KILOMETERS

stormwater loadings to the Fraser estuary were estimated for BOD5, total nitrogen, total phosphorus, coliforms, copper, iron, manganese, nickel, lead, and zinc (Table 10.3). Some contaminants are contributed mostly by wet weather flows, some mostly by dry weather flows, and some about equally. One of Ferguson and Hall's land use types is agriculture, which is considered in Appendix 11 of this report.

In their Summary Report, the FRES Water Quality Work Group recommended one year monitoring programs for typical industrial, commercial, and residential catchment areas (FRES Water Quality Work Group, 1979). This recommendation was implemented in 1981 for the 12.95 ha Rupert Street residential catchment basin in the Fraserview area of Vancouver (Swain, 1983). Swain found that pollutant loadings in stormwater were predominantly from precipitation or dustfall sources. All nitrogen was from precipitation as was most copper, zinc, and lead. Most chlorine and sodium was from dustfall, as was 70% of phosphorus. Pesticides could not be detected, though some PCBs were associated with grit. Total aluminum, copper, lead, and zinc increased with increased flows resulting in large metal loadings. BOD5, NFR, coliforms, TOC, cadmium, chromium, copper, lead, nickel, zinc, total phosphorus, ammonia, nitrate/nitrite, and total Kjeldahl nitrogen were lower than values reported in other stormwater studies. Copper, ammonia, nitrate/nitrite, organic nitrogen, manganese, and zinc concentrations were higher than those in the Fraser River, meaning increased river concentrations and impacts on toxicity. Lead and zinc in the stormwater sediments were higher than in Fraser River sediments, and were the only metals contributed in any significant way by stormwater. Contaminant loadings are dependant on the runoff coefficient. The average runoff coefficient of 0.4 derived in the study is lower than the coefficient of 0.45 used by Ferguson and Hall, and varies primarily with storm duration. A "first flush" effect was noted for suspended solids, lead, total nitrogen, chemical oxygen demand, aluminum, total organic carbon, copper, and zinc. Except for nutrients, total first hour loadings were found to be greater from stormwater than from the STPs during the same interval.

The industrial catchment area study monitored an active light industrial basin of 5.8 ha in the Norfolk Avenue area of Burnaby during 1982-83 (Lawson et al., 1985). The study found negligible contaminant loading from rainfall, but significant loadings of sodium, chloride, lead, and copper from dustfall. Concentrations of insoluble metals increased with increasing flows as NFR also increased, but dissolved metal concentrations decreased. However, total loadings of all contaminants increased with increasing flow. Overall, the study concluded that stormwater loadings were from material deposition to the drainage basin washed into sewers by runoff. Compared to the Ferguson and Hall study, the runoff coefficient was much lower, 0.31 versus 0.70, indicating that the study area may be atypical. BOD5, copper, nitrogen, nickel, and phosphorus loadings were lower than predicted by Ferguson and Hall, but iron, manganese, lead, and zinc loadings were higher (Table 10.4).

The most recent evaluation of contaminant loadings from stormwater is presented in the GVRD Liquid Waste Management Plan report of the Combined Sewer Overflow and Urban Runoff Committee (GVRD, 1988b). The committee derived estimated concentrations of urban runoff pollutants for both wet and dry weather, considered the volume, frequency, duration, and distribution of rainfall, selected runoff coefficients for summer, winter, and annual periods, and calculated urban runoff volumes and contaminant loads for Fraser River estuary reaches, Boundary Bay, and an overall total (Table 10.5). A similar type of evaluation was performed for combined sewer overflows, including analysis of volumes, frequencies, relation to total storms for summer and winter periods, and relation to storm intensity (Table 10.6). Conclusions were that contaminant loadings vary by source, most Fraser River fecal coliform loadings are from combined sewer overflows, and CSO nutrient loadings are double those from urban runoff. For the metals cadmium, copper, lead, and zinc, loadings from urban runoff in the Fraser system average 4.5 to 12 times greater than from combined sewer overflows.

10.4 Issues:

A fair amount of information now exists regarding stormwater contaminant characteristics and loadings, but is less developed for combined sewer overflows. While more information is needed to supplement existing information or fill data gaps, enough is known to determine that management of stormwater is desirable. Whether treatment is necessary, given the magnitude of environmental impacts and cost of treatment, is an issue still to be resolved. Other stormwater and combined sewer overflow issues include first flush effects, toxicity, separation of combined sewers, and illicit connections.

Stormwater and combined sewer overflow volumes fluctuate, and factors such as first flush effects and shock loadings become important. Both Swain (1983) and Lawson et al. (1985) found a first flush effect for some contaminants during the first one to three hours of stormwater drainage. These higher levels of contaminants suddenly discharged to receiving waters may shock biological communities.

Toxicity from the presence of contaminants in stormwater is a concern as it is for most effluent discharge types. Swain (1983) found that both wet and dry weather flows from a residential area were non-acutely toxic to rainbow trout, but dry weather flows may be acutely toxic to organisms lower in the food chain. Lawson et al. (1985) found the same results for an industrial basin. The LWMP Combined Sewer Overflow and Urban Runoff Committee concluded that more work is necessary to determine the toxicity of these discharges. Hall and Anderson (1988) found stormwater toxicity in the Brunette River basin increased in the land use sequence open space, residential, industrial, commercial, and that copper and zinc had the highest correlation with toxicity. Stormwaters discharge via numerous near-shore outfalls where mixing is less efficient and IDZs may overlap causing additive or synergistic effects from the toxicants. Discharges occur more frequently in winter, with longer average durations, when natural river flow levels are low and less dilution is available. Many stormwater outfalls are on the North Arm, where ambient water quality is lower than for the other reaches. In the case of the Brunette Basin, urban runoff is the main contributor of contaminants and receives virtually no dilution by ambient streamflow. Similarly, urban runoff in the Nicomekl and Serpentine Rivers is a substantial proportion of total stream discharge.

The issue of combined sewer separation depends upon minimizing overall contaminant impacts. In Greater Vancouver, combined systems deliver close to 50% of runoff for treatment though some raw sewage is discharged untreated when sewer capacity is exceeded. In spite of CSO, 98% of sewage flows in GVS&DD sewers are treated at the STPs. The LWMP Combined Sewer Overflow and Urban Runoff Committee (GVRD, 1988b) compared predicted quantities and loadings of contaminants in a completely separated sewer system to the current situation and found that a loading reduction would be achieved for all conventional pollutants except suspended solids. However, changes in loadings of organics and metals could be increased in some instances. They concluded that the environmental significance of contaminants in separated runoff would need to be better defined to evaluate sewer separation as a pollution control measure.

Sanitary sewers may be cross connected to storm sewers such that raw sewage flows continuously to receiving waters. These may result from construction error, or deliberate illegal connection. Sewer inspection programs identify and correct most such incidences. When sewer separation is carried out, on-site plumbing may lag behind and the full benefit of sewer separation may not be realized. In some cases, combined sewer tributary areas remain which connect to the separated stormwater line due to lack of capacity in the sanitary line.

10.5 Initiatives:

Initiatives taken for stormwater management in the Fraser estuary area include sewer use bylaws, sewer infrastructure modifications, and public awareness programs.

Municipal bylaws regulating storm sewer discharges are not as comprehensive as those for sanitary sewers (see Appendix 8). Storm sewers may be referred to in the same sewer use bylaws that regulate sanitary sewer discharges or there may be a separate storm sewer bylaw. Stormwater discharge criteria may be general requirements that only uncontaminated stormwater or cooling water be discharged to storm sewers, explicit listings of prohibited substances, or specifications of allowable contaminant discharge levels. Industrial site runoff to storm sewers is also a focus of concern, with some bylaws specifying control measures to restrict runoff.

The City of Vancouver has incorporated "first-flush" separators in its West End separate sewer system. These consist of a weir placed within sewers to direct low flows and the first flush of stormwater to treatment. Another sewer infrastructure modification is the GVRD elimination of cross-connections and raw sewage discharge program. In cooperation with municipalities, this consists of sewer inspections to reveal sources of sanitary sewage flowing uninterrupted to receiving waters, and interception of these for treatment. Wet ponds have been constructed in Surrey which retain stormwater from one storm to be replaced by the next. Treatment results from sedimentation, coliform die-off, and algae nutrient uptake.

An example of a public awareness program is the storm drain marking program, or "Yellow Fish" Program, sponsored by B.C. Recreational Fisheries Branch and DFO Salmon Enhancement Program. Major funding is provided by the Habitat Conservation Fund. The program involves the use of community volunteers, particularly young people, to identify street storm grates that drain to salmon bearing waterways. These are marked with a yellow spray-painted fish symbol intended to discourage the dumping of oil, grease, antifreeze, paints, solvents, pesticides, cleaning products, and other hazardous substances into the drain.

10.6 Remedies:

Options for dealing with the issues discussed above include storage and/or treatment, discharge modifications, or sewer separation.

Storage and treatment of stormwater is difficult because of the random, intermittent, high flow nature, and heavy sediment load of discharges. As most impacts might be from a first flush, an option could be to treat the first hour of discharge only. Stormwater volume during a first hour may approach 150,000 m^3, about half the daily discharge from the Annacis STP. Storage could be provided by modifying source catch basins, in-line systems, or by construction of off-line storage reservoirs. Treatment might include primary treatment in the GVRD STPs, or separate treatment facilities such as wet or dry settlement ponds. For combined sewer overflows, chlorination facilities could be provided. The LWMP Combined Sewer and Urban Runoff Committee evaluated a number of control alternatives (GVRD, 1988b), including runoff controls such as recharge devices, erosion control, ponding at source, street cleaning, and catchbasin cleaning; collection system controls such as monitoring, use of regulators, and sewer separation; and treatment controls such as detention ponds, off-line storage, and various treatment plant options.

The Waste Management Activity Program feels that implementation of source control and treatment options for urban runoff and combined sewer overflows is needed but must be carried out through an integrated plan which considers costs along with environmental benefits. It is the intention of the LWMP to carry out this task. This planning process will investigate all options involved with stormwater discharges and contaminant control. Municipalities or agencies could be encouraged to implement some of the options being investigated by the LWMP as a means of providing feedback on effectiveness. Other activities include an investigation of municipal bylaws that would encourage landscaping or building practices aimed at increasing surface infiltration rates such that runoff amounts are reduced, or increasing site storage such that flows during storm events are reduced. A

characterization of catchbasin clean-out sediments should be undertaken. Treatment or disposal of these as special wastes may be indicated.

In combined sewer areas, reduction of sanitary flows to sewer systems would provide more capacity for treatment of stormwater flows. Such reduction might be achieved through water conservation incentives for industry in source control programs, or public awareness programs encouraging water conservation. The sewer use surcharges implemented by Surrey and Langley Township resulted in decreased water consumption by the affected industries. Alternatively, water conservation or stormwater storage programs would provide more capacity for sanitary flows in the combined pipe, reducing the amount of combined sewer overflow.

Practices aimed at reducing toxicity of contaminant loads rather than the volume of stormwater flows are also an option. Outfall modifications to include subsurface discharges with diffusers would enhance effluent mixing with ambient waters. Street sweeping and vacuuming would remove contaminants from surfaces before rainfall washes them into stormsewers. Sweeping has been carried out in the Fraser estuary tributary area primarily for aesthetics reasons, and collects leaves, litter, and other large objects. Vacuuming is much more effective at removing smaller sized mineral and soil particles to which metal contaminants bind. Flushing contaminants into sewers during dry weather periods allows treatment in combined sewer areas without risk of combined sewer overflows. In separate sewer areas, flushing results in smaller quantities of contaminants entering receiving waters, to be more easily assimilated by the river. While the Waste Management Activity Program does support such activities, the emphasis is on activities that reduce contaminant loadings rather than those that disguise loadings by reducing toxicity.

Sewer separation allows elimination of combined sewer overflows but at the expense of increasing untreated stormwater runoff. Current sewer separation policy needs to be reviewed based on Pollution Control Objectives, Water Quality Objectives for the waterbody receiving the discharge, and criteria regarding the achievement of cost-effective environmental benefits. Separated systems could be constructed so that stormwater sewers are connected to the STPs. During storm events, overflows would then be from storm sewers only, eliminating overflows of sanitary sewage. However, current STP capacities are too low for this to be practical. Inline or offline storage capacity built into storm sewers would be needed to reduce or eliminate overflows. Water conservation practices or infiltration source controls could assist management of sewer line and STP capacities to maximize treatment efficiency.

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Table 10.1 ANNUAL URBAN RUNOFF, FRASER RIVER ESTUARY

Receiving waters	Runoff Volume (10^6 m^3)		
	Summer	Winter	Annual
Sturgeon Bank	0.2	1.1	1.3
Roberts Bank	0.1	0.7	0.8
Main Stem	6	36.1	42.1
Main Arm	2.5	14.1	16.6
Lower Main Arm	1.2	6.6	7.8
Upper North Arm	1.2	7.6	8.9
Lower North Arm	3	19.5	22.6
Brunette Basin	5.1	30.9	36
Pitt River	2.8	16	18.8
Coquitlam River	1.5	8.5	10
Fraser River Total	**23.5**	**141.2**	**164.8**
Boundary Bay	2.8	15.5	18.3
Serpentine River	9	51	60
Nicomekl River	5.4	30.4	35.8
Little Campbell River	1.2	6.8	8
Boundary Bay Total	**18.3**	**103.7**	**122**

(Source: GVRD, 1988b:Table 3.8)

Table 10.2 ANNUAL COMBINED SEWER OVERFLOW, FRASER RIVER ESTUARY

Receiving waters	Runoff Volume (10^6 m^3) (Typical Frequencies)		
	Summer	Winter	Annual
Main Stem	0.97	9.5	10.4
	(37)	(114)	(151)
North Arm	0.9	11	11.9
	(27)	(101)	(128)
TOTAL	**1.9**	**20.5**	**22.3**

(Source: GVRD, 1988b:Table 4.6)

Table 10.3 PREDICTED WET AND DRY WEATHER STORMWATER POLLUTANT LOADINGS

PARAMETER	WET WEATHER (kg/d)	(%)	DRY WEATHER (kg/d)	(%)	TOTAL (kg/d)
Flow (m^3/d)	695,000	66	356,000	34	1,050,000
BOD	14,800				14,800
Total nitrogen	1,200	52	1,100	48	2,300
Total phosphorous	400	82	86	18	486
Total Coliform ($x10^{12}$)	600				600
Fecal Coliform ($x10^{12}$)	56	95	3	5	59
Copper	12	67	6	33	18
Iron	200	10	1,800	90	2,000
Manganese	18	10	160	90	180
Nickel	2	33	4	67	6
Lead	30	47	34	53	64
Zinc	14	37	24	63	38

(Source: Ferguson and Hall, 1980)

Table 10.4 ESTIMATED INDUSTRIAL AND RESIDENTIAL URBAN RUNOFF LOADINGS

PARAMETER	INDUSTRIAL (a)	INDUSTRIAL (b)	RESIDENTIAL (a)	RESIDENTIAL (c)
Flow	144000	86,400*	326000	474,000**
BOD	4160	1553	9460	
COD		8401		1580
Suspended solids		23515		6974
Aluminum (total)		850		136
Chromium (total)		1.9		
Copper (dissolved)	7.05	4.03	3.24	12.3
Iron (Dissolved)		42		
Iron (total)	37.9	908	83.7	
Manganese (total)	6.92	24.6	7.44	
Nickel (total)	0.71		0.676	
Lead (total)	8.7	22	20.6	23.2
Zinc (total)	9.7	25	2.62	45
Kjeldahl Nitrogen		108		
Total Nitrogen	287	139	746	354
Total Phosphorus	87	49	275	50.4
Total Organic Carbon				558

All values in kg/day except flow, m^3/day.

* Possibly due to atypical study area.

** Precipitation 37% higher than normal.

Sources:

(a) Ferguson and Hall, 1980.

(b) Lawson et al., 1985.

(c) Swain, 1983.

Table 10.5 URBAN RUNOFF SUMMER AND WINTER LOADINGS, 1987

Parameter	Main Stem (a)		Main Arm (b)		North Arm (c)		Boundary Bay (d)	
(kg/day)	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Flow (m^3/day)	33,600	438,000	21,000	548,000	27,000	162,000	96,400	308,000
Suspended solids	1400	9900	810	5600	1000	7300	4200	28,300
BOD5							1200	6100
F. coliforms (MPN)	4.4×10^{10}	330×10^{10}	33×10^{10}	5×10^{10}	44×10^{10}	300×10^{10}	200×10^{10}	120×10^{10}
Total nitrogen							200	990
Total phosphorus			300	130			12	77
Cadmium	0.15	1	0.01	0.6	0.14	0.8	0.5	3
Copper	1.2	8	0.9	5	1	4	4	23
Lead							8	47
Zinc					3	20	13	76

Sources:
(a) GVRD,1988b:table 7.8
(b) GVRD,1988b:table 7.10
(c) GVRD,1988b:table 7.12
(d) GVRD,1988b:table 7.16

Table 10.6 CONTAMINANT LOADINGS FROM URBAN RUNOFF AND COMBINED SEWER OVERFLOWS

Parameter	Main Stem(a)		Main Arm(b)	North Arm(c)		Boundary Bay(d)	Annual Average (e)	
(kg/day)	Urban Runoff	CSO	Urban Runoff	Urban Runoff	CSO	Urban Runoff	Urban Runoff	CSO
Flow (m^3/day)	111,600	21,260	68,900	93,800	39,700	327,700	602,000	62,100
BOD						3,615	8,215	3,700
F. Coliforms (MPN)	1.9×10^{12}	82×10^{12}	2.5×10^{12}	1.6×10^{12}	160×10^{12}	6.3×10^{12}	12.3×10^{12}	242×10^{12}
NFR	5,600	1,300	3,070	4,180	2,390	16,280	29,130	3,690
Ammonia							93	240
Total Nitrogen					584			
Total phosphorus		7.4			44.6		58	116
Cadmium	0.6	0.1	0.3	0.4	0.14	1.6	2.9	0.2
Copper	4.5	1.7	2.6	3.6	3.1	13.4	24.1	4.8
Lead						27.6	33	5.5
Zinc		1		11.8	4	44.3	59	5

Sources:
(a) GVRD, 1988b:table 7.8
(b) GVRD, 1988b:table 7.10
(c) GVRD, 1988b:table 7.12
(d) GVRD, 1988b:table 7.16
(e) GVRD, 1988b:table 7.3

Appendix 11 Agricultural Wastes and Rural Runoff

11.1 Introduction:

Areas of Richmond, Delta, Langley, the Serpentine and Nicomekl basins of Surrey, Pitt Meadows, Maple Ridge, along the Coquitlam River in Port Coquitlam , and the Big Bend area of Burnaby are in agricultural land reserves, and are unserviced by sewers (Map 5). While reserves include dormant or undeveloped land, such as Burns Bog in Delta, much is farmland. Fertilizers added to fields, pesticides sprayed on crops, and leachates from inadequate farm waste storage may contaminate runoff or groundwater flows. Manure from dairy or hog farms may be disposed of in tile fields or spread on land. BOD, nutrients, and fecal coliforms in manure can then seep or run off into receiving waters. Significant environmental effects are occurring from the release of these pollutants into the streams and tributaries of the Fraser River.

11.2 Area Characteristics and Flows:

Ferguson and Hall (1980) included agricultural land use in their estimate of stormwater runoff. By multiplying expected rainfall and agricultural area in each municipality, and multiplying this total by an assumed agricultural runoff coefficient of 0.2, Ferguson and Hall derive a total agricultural runoff flow averaging 67,900 m^3/day. This total does not take irrigation into consideration. Most of the agricultural runoff is in Richmond and Delta (Table 11.1)

The Combined Sewer Overflow and Urban Runoff Committee of the GVRD LWMP included agriculture in their estimate of flows from nonpoint sources (GVRD, 1988b). For each municipality, the land area in ALRs is multiplied by the average municipal rainfall, irrigation values are as reported by the Water Use/Water Quality Committee of the LWMP (GVRD, 1988e), and a runoff coefficient of 0.3 is used (Table 11.2). Their estimate was for a flow of 632,000 m^3/day. As irrigation accounts for only 1% to 10% of total flows, the major difference between these two flow estimates is in the methodology used. Discussions of stormwater flows in Appendix 10 may include flows from agricultural lands, so flow estimates from agriculture may already have been accounted for in that section.

Agricultural drainage from Delta into Boundary Bay is primarily through five pump stations which lift runoff over the dykes (Table 11.3). These pump station discharges have been identified as major sources of pollution to the Bay (Higgs, 1989).

Agricultural land uses include raspberry, blueberry, strawberry, and cranberry cultivation in Richmond. Vegetable farms are found in the Big Bend area of Burnaby, the Nicomekl and Serpentine floodplain, and some parts of Richmond. Some dairy farms are found in the upper areas of the Nicomekl and Serpentine basins, and other areas of the Fraser delta. Nurseries, market gardens, and hobby farms are also found in parts of the region.

Table 11.1 ESTIMATED RUNOFF FROM AGRICULTURAL AREAS, 1979

Municipality	Runoff (m^3/day)
Burnaby	550
Coquitlam	1,100
Delta	24,700
Port Coquitlam	820
Richmond	24,400
Surrey *	9,400
TOTAL	**60,970**

* Includes Open Spaces.

(Source: Ferguson and Hall, 1980)

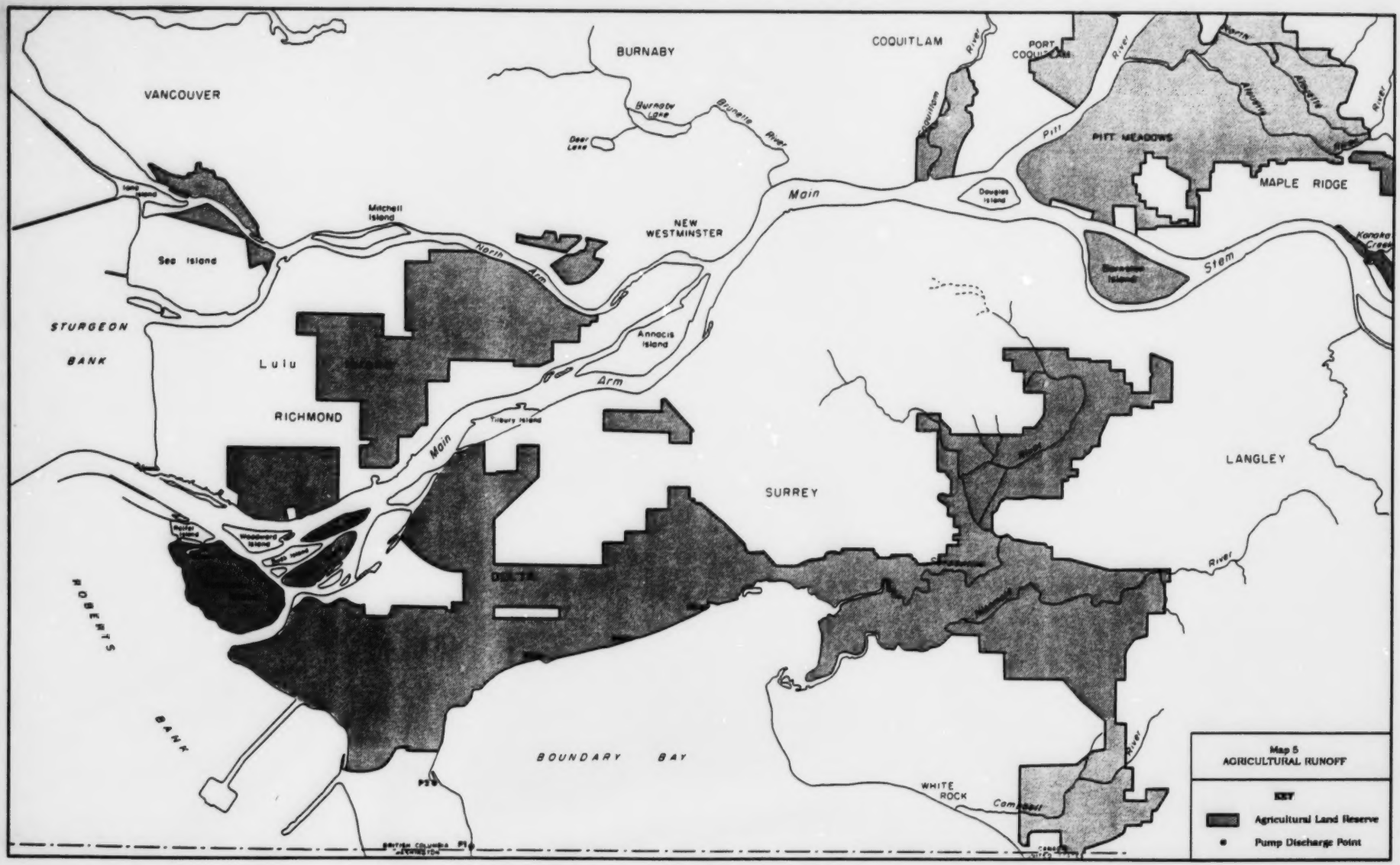
VANCOUVER
BURNABY
COQUITLAM
PORT COQUITLAM
PITT MEADOWS
MAPLE RIDGE
NEW WESTMINSTER
RICHMOND
SURREY
LANGLEY
DELTA
WHITE ROCK
BOUNDARY BAY
STURGEON BANK
ROBERTS BANK
Sea Island
Lulu Island
Mitchell Island
Annacis Island
Douglas Island
Barnston Island
Tilbury Island
Woodward Island
Deer Lake
Burnaby Lake
Brunette River
Coquitlam River
Pitt River
North Alouette River
Alouette River
Kanaka Creek
North Arm
Main Arm
Main
Stem
Serpentine River
Nicomekl River
Campbell River
Canoe Pass
Map 5
AGRICULTURAL RUNOFF
KEY
Agricultural Land Reserve
Pump Discharge Point
KILOMETERS

Table 11.2 ESTIMATED RUNOFF FROM AGRICULTURAL AREAS, 1987

Reach	Land Area in ALR (km^2)	Yearly rainfall (mm)	Yearly irrigation (mm)	Runoff (m^3/day)
Main Stem	89	1,650	12	121,500
North Arm	24.6	1,200	12	24,700
Main Arm	46.3	1,140	12	44,700
Fraser Tributaries	85	1,780	12	126,900
Little Campbell	37.3	1,270	31	40,200
Nicomekl	86.5	1,520	64	112,300
Serpentine	56.6	1,400	21	65,800
Boundary Bay	99.3	1,140	38	95,900
TOTAL	**524.6**			**632,000**

(Source: GVRD,1988b)

Table 11.3 BOUNDARY BAY PUMP STATION LOCATION AND DISCHARGE

Number	Location	Discharge capacity (m^3/day)
P1	Third Avenue (Beach Grove)	52,370
P2	Twelfth Ave (Beach Grove)	98,194
P3	Boundary Bay Airport	52,370
P4	Beharrel	130,925
P5	Oliver Street	229,118

11.3 Loadings:

By applying assumed pollutant concentrations to the estimated runoff from agricultural lands, Ferguson and Hall (1980) derive predicted loadings from agricultural areas by municipality. By assuming that agricultural land reserves in Burnaby and half of Richmond drain to the North Arm, those in Coquitlam and Port Coquitlam drain to the Main Stem, those in half of Richmond and half of Delta drain to the Main Arm, and those in Surrey and half of Delta drain to Boundary Bay, a basis for comparison with the LWMP Combined Sewer Overflow and Urban Runoff Committee (GVRD, 1988b) estimates of agricultural loadings is provided (Tables 11.4 and 11.5). Differing fertilizer or pesticide use practices that may lead to different contaminant loadings are not taken into account by these loading estimation methods.

Since a fish kill in 1980, Waste Management Branch personnel have undertaken a water quality monitoring program on the Serpentine River (Moore, 1984). Other investigators, notably Hutton (1987), have also investigated water quality conditions at locations along the Serpentine and Nicomekl Rivers. However, no contaminant loading estimates have been reported for specific discharges.

11.4 Issues:

Evaluation of agricultural waste issues is inhibited by lack of data. Information that does exist indicates problems with oxygen demanding substances discharged into the low oxygen level waters of the Serpentine and Nicomekl Rivers. Fertilizer and pesticide misuse can result in contaminated runoff to the Fraser River. Management and regulatory issues include the effectiveness of the Agricultural Environment Services program of the Ministry of Agriculture and Fisheries, and the traditional farm exemption from the Waste Management Act.

Table 11.4 ESTIMATED LOADINGS FROM AGRICULTURE, 1979

Reach	BOD5	Total Nitrogen	Total Phos.	Fecal Coliforms	Copper	Lead	Zinc
Main Stem*	5	4	0.18	5	0.005	0.005	0.005
North Arm	36	26	1.1	36	0.036	0.036	0.036
Main Arm	70	49	2	70	0.08	0.07	0.07
Boundary Bay*	40	32	1.5	35	0.06	0.05	0.05

* including tributaries
Values are kg/day except fecal coliforms, number x 10^{10}.

(Source: Ferguson and Hall, 1980)

Table 11.5 ESTIMATED LOADINGS FROM AGRICULTURE, 1987

Reach	BOD5	Total Nitrogen	Total Phos.	Fecal Coliforms	Copper	Lead	Zinc
Main Stem	365	243	12	1200	0.36	0.36	0.36
North Arm	74	49	2.5	250	0.07	0.07	0.07
Main Arm	132	88	4.4	440	0.13	0.13	0.13
Fraser Tributaries	379	253	12	13,000	0.4	0.4	0.4
Little Campbell	120	80	4	400	0.12	0.12	0.12
Nicomekl	337	225	11	1100	0.34	0.34	0.34
Serpentine	198	132	6.5	660	0.2	0.2	0.2
Boundary Bay	288	192	9.5	960	0.29	0.29	0.29

* including suspended solids
Values are kg/day except fecal coliforms, number x 10^{10}

(Source: GVRD, 1988b)

Major fish kills occurred during fall on the Nicomekl or Serpentine Rivers in 1980, 1983, 1984, and 1986. These kills were due to low dissolved oxygen levels. Causes of low oxygen levels are the annual algae die-off, and drainage of oxygen demanding substances from agricultural areas. Nutrient loads in agricultural runoff contribute to algae blooms. Oxygen demanding materials include manure BOD and nutrients which may be flushed from fields or drainage ditches during fall storms, corresponding to the algae die-off period (Town and Mavinic, 1986). Manure containment facilities are commonly emptied in the fall onto newly harvested fields. Upper reaches of the Anderson Creek tributary of the Nicomekl River flow through dairy, beef, hog, and sheep farms (Hutton, 1987). Animals on dairy or hog farms are often kept in barns year-round and generate large amount of animal wastes which are typically stored before being spread on fields. Leachates from inadequate storage or runoff from fields contribute significant loadings of ammonia and phosphorus, comparable to that from STPs (Hutton, 1987). Oxygen levels in the Serpentine and Nicomekl Rivers may be satisfactory for all but two weeks of the year, but these two weeks may coincide with major salmon runs.

Tidal gates at Highway 99A are designed to prevent salt water intrusion into both Serpentine and Nicomekl Rivers, acting to preserve fresh water in the lower reaches for irrigation purposes. Many ditches drain to the rivers through flap gates, similarly preventing reverse flows at high river water levels. When gates are closed, oxygen levels of entrapped waters may drop to stress levels. Plugs of nutrient-rich, oxygen-poor water released from ditches are a prime cause of fish kills. The Serpentine and Nicomekl systems discharge about 115 x 10^6 m^3/year to Mud Bay (Town and Mavinic, 1986), 65 x 10^6 m^3 (56%) of this is agricultural runoff if LWMP Combined Sewer Overflow and Urban Runoff Committee estimates are accepted. Much of the remainder is urban runoff flow so there is little dilution capacity for contaminants in the system. Control of contaminant concentrations in discharges assumes more importance in such cases.

The larger dilution capacity of the Fraser River decreases the overall significance of contaminant loadings relative to the Serpentine or Nicomekl Rivers, but a tidal cycle effect causing backup of waters in small ditches, and subsequent release of contaminated waters, contributes to localized toxic effects. While cattle, hogs, and horses are raised in the Salmon River basin which drains into the Fraser just upstream of the study area limits at Kanaka Creek, most Fraser River drainage is from vegetable and berry farms. Overfertilization and pesticide use may cause contaminant problems from nutrients and pesticide residuals in waters draining into the Fraser River. No data are available to adequately interpret the extent of the problem in this area. The pesticide parathion is used on cranberry farms in Richmond, for instance, and significant runoff occurs when berries are harvested (Williams, 1987).

Commencing in 1975, the Agricultural Environmental Services Program (AESP), of the B.C. Ministry of Agriculture and Fisheries, was implemented to deal with pollution and sanitary concerns arising from agricultural activities. The process involves a peer-group inspection following reception of a complaint. The program has not always produced satisfactory results as resulting recommendations have not always reflected the concerns of environmental agencies or the public (Hutton, 1987). In principle, a self-policing approach can be satisfactory, but in some cases it can be ineffective. Agricultural wastes are a Class B exemption under Waste Management Act regulations. This traditional exemption is under pressure for review because farm wastes are exceeding the capacity of existing farm waste management strategies.

11.5 Initiatives:

Following the 1980 Serpentine fish kill, the Surrey WMB office developed a sampling program to determine causes of the low oxygen levels and to suggest remedial actions. Further fish kills lead to the formation of an interagency group in July 1984. Stream aeration was one of the remedial measures recommended by the group. A stream aeration project for the Serpentine River was undertaken by a graduate student in the Environmental Engineering Group, Civil Engineering Department, University of British Columbia, in 1985-1986 (Town and Mavinic, 1986). Aeration has proven to be a successful lake enhancement technique in B.C., and has had some success on the Serpentine River. Compared to other options, in-stream aeration can be designed and installed relatively quickly, at relatively low cost. However, it does not address the basic problem of excessive nutrient loadings to these streams or the question of pesticide residuals in the water.

The Ministry of Environment established an Agricultural Waste Management Committee in 1987 with representation from the Waste Management Branch, B.C. Ministry of Agriculture and Fisheries, B.C. Federation of Agriculture, the federal Department of Fisheries and Oceans, and the Greater Vancouver Regional District to review agricultural waste management practices throughout B.C. The committee is in the process of drafting an agricultural regulation to the Waste Management Act that will allow for the continuation of permit exemptions subject to observed waste management standards. The Ministry of Agriculture and Fisheries is developing Codes of Agricultural Practices that will detail the practical and environmentally sound standards required to retain the exemption. The regulation is intended to be implemented by March 1990 following consultation with the agricultural industry commodity groups.

Following a National Agriculture Strategy endorsed by Ministers of Agriculture in November 1986, B.C. has established a provincial strategy for soil and water. The strategy establishes provincial priorities for land and water related issues, establishes objectives, principles, and guidelines for programs, and provides a basis for negotiating federal-provincial soil and water programs for the benefit of B.C.'s agricultural industry. Within this strategic plan, issues such as the effect of agriculture on soil and water quality will be addressed and will require the need for detailed inventories to determine the current manure

storage, land application, and pollution situation in areas of interest to FREMP. The Ministry of Agriculture and Fisheries is presently determining the availability of funds on a cost sharing basis with the federal government.

A 1987 contract was let through the B.C. Ministry of Environment to study water quality, primarily dissolved oxygen levels, identify problem areas, recommend corrective measures, and note areas requiring further study in four lower Fraser valley agricultural watersheds (Hutton, 1987). Due to low water levels which inhibited the value of water chemistry measurement, the emphasis of the study was changed to compiling a farm inventory in the Sumas watershed.

11.6 Remedies:

Options for dealing with agricultural wastes are ill-defined due to lack of good information on agricultural waste practices, composition, sources, and environmental pathways. This lack of data makes it difficult to determine the extent and severity of the problem of agricultural waste. Without this knowledge it is impossible to recommend the types of activities that are needed to resolve the problems. An accurate impact assessment would determine the extent and severity of low dissolved oxygen impacts from organic wastes and impacts from pesticide residues in streams or ditches. An inventory of farms for the Serpentine and Nicomekl basins such as was carried out by Hutton (1987) for the Sumas watershed is of initial importance. Such a survey would identify farm type, number of animals, waste containment facilities, and waste disposal practices. While livestock and poultry farms are not as common in the Serpentine and Nicomekl systems as they are in the Sumas basin, a limited number can still cause dissolved oxygen problems. An inventory should be extended to include a site registry of ditches and other agricultural waste discharge points similar to that for stormwater. An examination of Map 4 shows no inventoried stormwater discharges for the Nicomekl and Serpentine drainage basins. Five pump stations are major sources of pollution to Boundary Bay from Delta. An upstream survey from these pump stations is needed to identify the pollution sources and propose remedial actions.

Options that could be developed include alternate farm management practices for fertilizer and pesticide use, alternate waste disposal methods, treatment facilities for manure and other agricultural waste streams, and environmental enhancement within the streams that have been impacted. The Agricultural Waste Committee is developing an Agricultural Waste Code of Practice in conjunction with an Agricultural Waste Regulation for the Waste Management Act. Funding for an inventory of farm types, research on agricultural land use, fertilizer and pesticide use practices, and a site registry of drainage ditches and streams, necessary for contaminant management of Fraser River area agricultural waste, might be recommended, perhaps under the national Agriculture Strategy.

Economic incentives have been discussed for some previous areas of concern. Policy options that are applicable to nonpoint agricultural discharges include taxes on the use of materials known to result in contaminant loadings, or regulation of the use of such materials. Education of farm owners and operators regarding the impacts of agricultural wastes and farm management practices that would alleviate these impacts should be an integral part of the activity plan. The process of inventorying farms can be used to enhance awareness of agricultural waste issues by providing the operator with background information as to why inventory data is being requested.

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Appendix 12 Groundwater Contamination

12.1 Introduction:

Groundwater flows are subsurface seepages of water replenished by rainfall infiltration. Discharges to ground, landfill leachates, underground storage tank leakage, and septic tank seepages are sources of contaminants to groundwater flows that may eventually reach the river. Discharges to ground include industrial cooling and process wastewater streams going to sediment ponds, lagoons, or infiltration ponds and pits. Leachates are generated when water infiltrates through any kind of solid waste dump site, including woodwaste landfills. Where sewers are not available, domestic and industrial sewage is discharged to septic tanks, tile fields, or holding tanks.

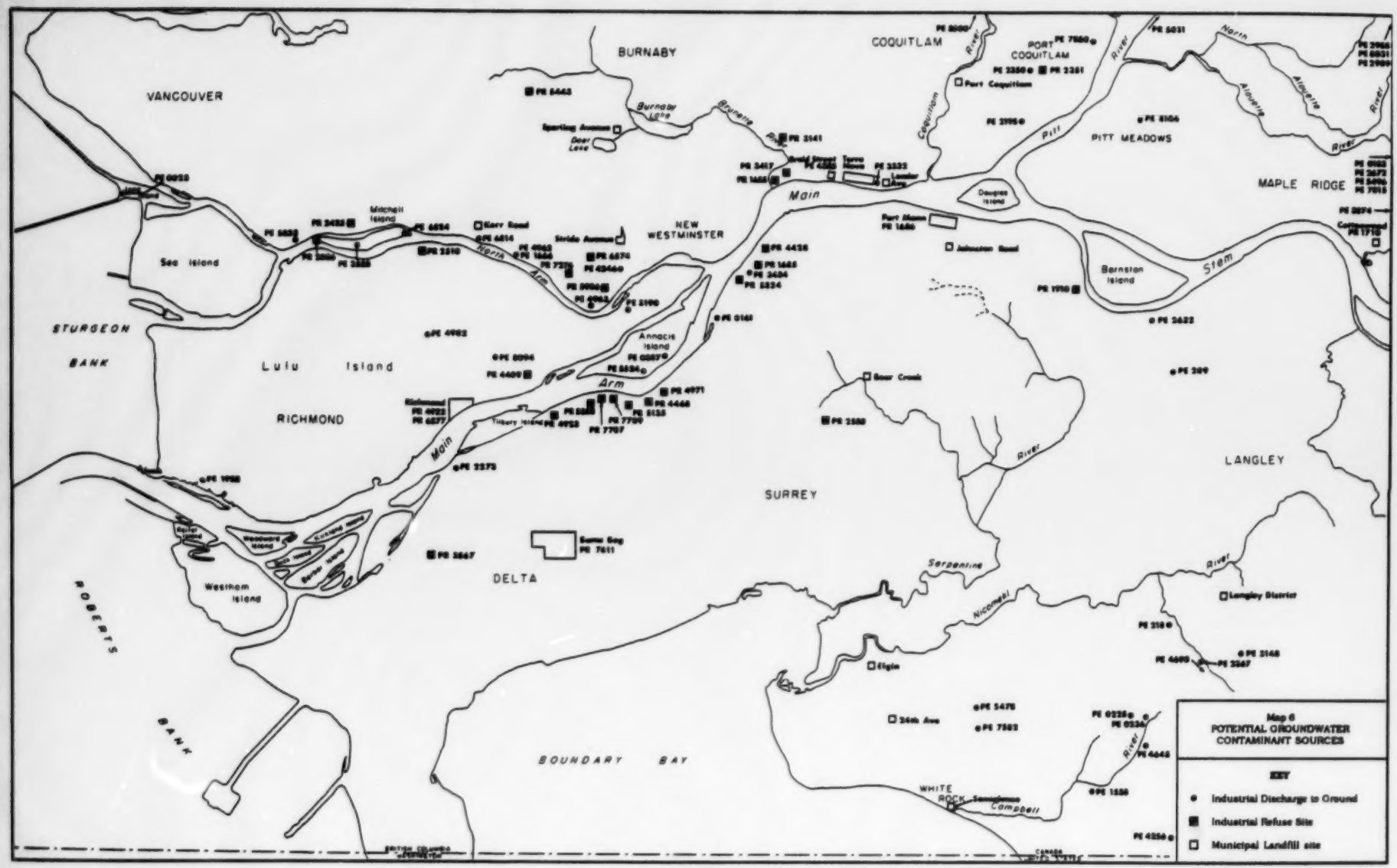
12.2 Area Characteristics and Flows:

Currently, there are 43 WMB permits for effluent discharges to ground (Table 12.1, Map 6). Permitted discharge volumes range from 0.5 m^3/day to 2,273 m^3/day, though only 5 discharges are over 123 m^3/day. One third of these discharges are treated effluent discharges to tile fields, which should have no environmental effects barring failures. Many others are from cooling water streams in lumber mills, truck wash water from concrete plants, boiler blowdowns, and other relatively innocuous wastes.

Atwater (1980) classified landfills into four categories: large active municipal landfills, large closed municipal landfills, woodwaste landfills, and small municipal and miscellaneous landfills (Table 12.2, Map 6). Except for the Kerr Road and Stride Avenue landfills which are located in upland gullies, and the Leeder Avenue fill which has a sand base, all large municipal landfills are located on peat bogs. The peat acts as an impermeable layer to vertical water flows, and leachate collected in control works can approach 99% of the total (Atwater, 1980). Flows from large municipal landfills are difficult to determine due to indeterminate flow pathways, but estimates range between 200 m^3/day and 5,000 m^3/day for the Stride Avenue fill and the Richmond fill respectively. Leachates from Burns Bog, Port Mann, Braid Street, Kerr Road, and Terra Nova fills are collected and discharged to the Annacis STP. Leachates from the Richmond fill are collected, treated on-site, and discharged to the Main Arm. The Fraser River Harbour Commission holds a WMB permit to discharge 10,000 m^3/day from the Richmond fill. Only Burns Bog and Port Mann are still accepting refuse.

All small municipal landfills are closed except for the Cottonwood fill in Maple Ridge. Leachate impacts have been noted for Maple Ridge, Johnstone Road, and Bear Creek fills. Leachates of 500 m^3/day from the Cottonwood site are collected and discharged to the Annacis STP. Other flow estimates for these fills are unavailable, but leachate effects are not expected to be significant. A number of industrial refuse sites have permits from the WMB (Table 12.3, Map 6). For many, leachate generation is probable, but flows are unknown. Industrial landfill sites are also required to obtain a permit, except construction preload which is exempt. Fill is primarily inert industrial materials and sites are not listed in Table 12.3.

Shake and shingle, lumber, and plywood mills in the area all produce sawdust, hog fuel, chips, bark, butt ends, and debris. In 1977 an estimated 470,000 tonnes of woodwaste was landfilled in the lower Fraser Valley (Atwater, 1980). In 1987, 1.5 x 10^6 m^3 of woodwaste was produced by mills located in the Fraser estuary area (WMB files), and much more is trucked in for disposal from the Mission/Albion area. Some of this woodwaste is used as fuel, some is incinerated, but most is deposited in landfills. A primary use of woodwaste has been as a fill base for boggy or compressible soils. With water contact however, leachates are formed. These contain toxic materials such as resin acids, tropolones, terpenes, tannin, and lignin. Leachates also contain nutrients that may promote fungal growth. Wastes from wood


VANCOUVER
BURNABY
COQUITLAM
PORT COQUITLAM
PITT MEADOWS
MAPLE RIDGE
NEW WESTMINSTER
Sea Island
Lulu Island
Annacis Island
RICHMOND
SURREY
DELTA
LANGLEY
Barnston Island
Westham Island
STURGEON BANK
ROBERTS BANK
BOUNDARY BAY
WHITE ROCK
Fraser River
Main Arm
North Arm
Pitt River
Coquitlam River
Burnaby Lake
Deer Lake
Mitchell Island
Douglas Island
Sturgeon Bank
Sour Creek
Serpentine River
Nicomekl River
Campbell River
Elgin
24th Ave
Langley District
Map 6
POTENTIAL GROUNDWATER CONTAMINANT SOURCES
KEY
Industrial Discharge to Ground
Industrial Refuse Site
Municipal Landfill site
0 1 2 3 4 5 KILOMETERS

exposed to antisapstain treatments may leach chlorophenols, arsenic, and copper. During groundwater infiltration, leachates may dissolve and activate soil metals. Highway or road construction and housing developments in boggy or compressible soil areas of Richmond have been the greatest recent users of woodwaste.

Failing or seeping tile fields or septic tanks may contaminate groundwater. Discharges to tile fields located in low lying areas are effectively a direct discharge to the river due to high water tables. The LWMP Combined Sewer Overflow/Urban Runoff Committee (GVRD, 1988b) estimates 15 North Arm residences and 120 Main Arm residences are discharging either directly to the river or to low lying tile fields. For Fraser River tributaries, they estimate 3,200 residences, many of these summer use only. For Boundary Bay tributaries 3,600 residences are estimated.

12.3 Loadings:

Loading values for municipal landfills are difficult to determine because total flows are not known with any accuracy. Studies that have been done indicate a wide range of concentrations (Atwater, 1980). The significant leachate contaminants in Fraser River area fills are ammonia, chloride, and COD. Other than iron, manganese, zinc, aluminum, and arsenic, metals are generally found in low quantities or are not detectable (Tables 12.4 and 12.5). No estimates exist for total leachate generation and contaminant loadings from small closed municipal landfills or from industrial effluent discharges to ground and refuse landfills. Atwater (1980) estimated a total 1979 woodwaste leachate loading of 5000 to 16,000 kg/day of COD, 91 kg/day of iron, and 24 kg/day of ammonia.

The LWMP Combined Sewer Overflow and Urban Runoff Committee (GVRD, 1988b) estimates septic tank loadings by assuming that flows from residences near the Fraser River all enter the river but only 10% of actual loadings enter from residences near tributaries (Table 12.6). Impacts from septic tanks along tributaries are more significant than along the main reaches of the Fraser.

12.4 Issues:

The four main sources of leachate generation and groundwater contamination in the Fraser estuary study area are municipal landfills, discharges to ground, industrial refuse dumps, and woodwaste landfills. For each of these, primary issues are the lack of good data regarding leachate infiltration, leachate composition, and impacts of groundwater contamination. Material deposited in landfills can be a very complex mix, and leachates from these combinations may be highly toxic. Regulation procedures, monitoring, and testing for compliance are also issues which need to be addressed.

Atwater (1980) found that net water infiltration occurred, and leachate was produced, at every one of the landfills he assessed. Leachate generation from the large municipal landfills is now monitored, collected, and either treated on site as for the Richmond Landfill, or discharged to sewer. Due to the hydrogeology of the landfill sites, most leachate is collected, but some escapes to infiltrate with groundwater flows and reach the river untreated. Uncollected leachate would be of the same composition as for collected (Table 12.4), but volumes, and therefore loadings, are unknown. A main issue with large municipal landfill leachates appears to be the large contribution of ammonia to the Annacis STP. Small closed municipal landfills do not appear to be discharging deleterious amounts of leachate to the environment, but may be causing localized impacts. Some monitoring at these sites was done in 1983 (Moore, In Prep.).

The 1986 effluent monitoring program (Supervisory Coordinating Committee, 1987) investigated five industrial sites with potential problem leachate generation from lagoons or landfills: Titan Steel and Wire, Tree Island Steel, Western Canada Steel (now closed),

Paperboard Industries, and Chatterton Petrochemicals, which includes the old Dow Chemical spill sites. Examination of industrial discharges to ground permits (Table 12.1), and refuse permits (Table 12.2) indicates that Kennametal, Hilinex, Reliance Foundry, and United Auto Wreckers could also be included on this list of potential groundwater contaminant sources. Little information is available about contaminants from discharges to ground and refuse dumps, and regulation is difficult as no pollution control objectives exist for these pollutant types. Quite possibly, not all industrial ground discharges or refuse dumps are known or have permits (see Appendix 13 for discussion of unauthorized dumps). Also, little is currently known of the extent of groundwater contamination by chlorophenols or other wood preservation compounds leaching from treated wood products stored at forest company yards or bulk loading facilities.

The main issue associated with woodwaste is in their disposal. While woodwastes are a Class C exemption under Waste Management Regulations and no permit is required, those responsible for woodwaste deposition still need to observe the intent of the Waste Management Act. The unique characteristics of woodwaste as a fill preparatory material indicate that it will continue to be used in fill sites, especially in boggy or compressible soil areas (Moore, 1980). The issue becomes the proper control of woodwaste landfills such that deleterious amounts of leachate are not generated, or if generated, are properly collected for disposal. Education of mill operators, truckers, developers, and the public regarding woodwaste impacts and control is important.

12.5 Initiatives:

The GVRD is investigating leachate migration from the Port Mann landfill, and other researchers are investigating leachate significance and contaminant sources. The GVRD is also implementing a regional solid waste recycling Action Plan. The GVRD refuse incinerator plant in Burnaby now accepts 20% of regional garbage, though disposal problems remain for the ash residues. Many municipalities are developing or implementing recycling acitivities such as the neighbourhood Blue Box program, which will reduce the amount of refuse disposed in municipal landfills.

The woodwaste leachate problem is being addressed through increased awareness. Early in 1988 WMB circulated a letter to mill owners, operators, trucking firms, and others associated with woodwaste deposition outlining the woodwaste problem, impacts, and regulations under the Waste Management Act. This effort has had some success in raising awareness and addressing disposal concerns. Where sampling shows woodwaste leachates to be a problem, a pollution abatement order can be issued by the Waste Management Branch. If no action is taken by the owner, charges may be laid under the WMA.

12.6 Remedies:

Treatment of landfills to prevent leachates is a matter of preventing water infiltration. This can be done by locating fills on impermeable substrates, filling discrete cells that are separated by impermeable walls, and covering with impermeable material that directs precipitation away from the fill material. Where leachates are generated, these can be collected in wells, ditches, or stream courses, diverted to STPs, or treated on-site. Most municipal landfill sites are managed according to these principals. Monitoring at large municipal landfills, and periodic monitoring of closed municipal landfills, should be continued. The amount of leachate not being collected or treated should be estimated, and means of collecting this leachate should be investigated. Avoiding leachate generation by preventing landfill of certain materials should be pursued. Some waste gyproc can be recycled through gypsum transfer stations. Research is needed to discover alternate uses of both solid waste and woodwaste, incentives such as taxes, tax breaks, grants, and fees for dumping should be explored, and public awareness programs developed towards minimizing

the amounts of materials discarded. Again coordination is needed, and can be facilitated through FREMP.

For industrial sites, it should be determined whether pollution control objectives are desirable for discharges to ground. This would involve an evaluation of existing WMB permits regarding amounts, concentrations, and loadings resulting. While many of these discharges are generally considered to be innocuous, the potential for metal loadings, pH extremes, and temperature extremes exists. Pollution control objectives do exist for refuse dumps, but these address the operation of dumps, not leachates directly. When pollution control objectives are revised, attention should be given to leachate quality criteria. A leachate extraction procedure is detailed in the Special Waste Regulation of the WMA. materials leaching scheduled substances should not be landfilled in any case. An investigation could be undertaken regarding the extent of groundwater contamination by chlorophenols and other chemicals leaching from treated wood as an extension of previous storm runoff studies by Environment Canada.

Following a WMB review of hog fuel sites and water chemistry in the South Westminster Area (Gough and Moore, 1980), several recommendations were made for woodwaste landfill leachate control. These include isolation from water courses, use of an impermeable berm-cover fill system, and monitoring for leachate release. Ideally, a 10 meter or wider leave strip would be provided, wider on high porosity sites. Inside this strip, a berm would be constructed of impermeable materials on a surface from which plant material and humus soils have been removed. The site would then be filled in such a manner that the exposed woodwaste face is minimized, and covered with impermeable material weekly or monthly depending on fill volume. The cover should be graded to direct runoff away from the woodwaste, and flows towards the fill site should be diverted. Following completion of the fill, monitoring should ensure that the cover does not erode, and that leachate does not seep from the berm. Corrective measures include sealing or collecting and treating leachates. Woodwaste landfill violations of the WMA are investigated by WMB personnel as potential problems are identified. Enforcement is through pollution abatement orders, with charges laid if no action is taken. The process is difficult to administer given the magnitude of woodwaste deposition. The possibility of municipal by-laws aimed at regulation of woodwaste should be investigated and implemented where practical. Building code, construction, or dumping bylaws could be considered.

A formal patrol-type program on a scheduled basis to find cases of unauthorized discharges to ground, industrial refuse sites, illegal dumps, woodwaste fills, and evidence of groundwater contamination is needed. Presently, incidences are reported by citizen complaint or by the serendipitous observations of WMB technicians. Coordination of Waste Management personnel, NFHC and FRHC personnel, DFO fisheries officers, EP personnel, MOE Conservation officers, MOH inspectors, and municipal bylaw inspectors is necessary and can be facilitated through FREMP. This should be part of a surveillance and enforcement strategy for the estuary.

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Table 12.1 WMB PERMITS FOR DISCHARGES TO GROUND

Permit	Name	R	Industry Type	Discharge Type	Volume m^3/day	Comments
PE0023	Iona Island	MA	STP	Sludge		Sludge waters to sewage lagoons.
PE0183	Alouette Cor. Ctr.	MS	Municipal	Sewage	230	Treated effluent to tile field.
PE0161	Titan	MA	Metal	Cooling	55	Clarifier underflow to sediment pond and infiltration lagoon.
PE0209	Smith Trailer	BB	Municipal	Sewage	55	Treated effluent to tile field.
PE0218	W. and G. Smith	BB	Municipal	Sewage	29.55	Treated effluent to tile field.
PE0225	M. Gurtitz	BB	Municipal	Sewage	46.4	Treated effluent to tile field, with PE0236.
PE0387	Annacis Island	MA	STP	Sludge		Sludge waters to sewage lagoons.
PE1558	Hazelmere Camp	BB	Municipal	Sewage	22.7	Treated effluent to tile field.
PE1666	Mac. Bloedel	NA	Forest	Cooling	12	Planer guide cooling water to land.
PE1928	Imperial Oil	MA	Petroleum	Process	6	Treated stormwater to infiltration bed.
PE2195	Silkwood Ent.	MS	Food	Cooling	3.6	Cooling water to infiltration pit.
PE2273	Tri Mac	MA	Concrete	Process	46	Truck wash to infiltration pond.
PE2350	Kennametal	MS	Chemical	Process	45	Refinery effluent to infiltration pond.
PE2632	Kockums Cancar	MS	Municipal	Sewage	45.4	Treated effluent to tile field.
PE2673	PVC	MS	Municipal	Sewage	91	Treated effluent to tile field.
PE3148	School District 35	BB	Municipal	Sewage	54.6	Treated effluent to tile field.
PE3190*	Tree Island	NA	Metal	Combined	1350	Treated process and domestic effluent to infiltration pond.
PE3332*	Lafarge	MS	Concrete	Process	53.2	Truck wash to settling pond
PE3434	Weldwood	MS	Forest	Combined	272	Boiler blowdown to infiltration pit.
PE3555	Liquid Carbonic	NA	Chemical	Combined	2.3	Occasional miscellaneous discharge.
PE3874	Bochee Kennels	MS	Municipal	Sewage	3.2	Treated effluent to tile field.
PE4246	ABC Recycling	NA	Metal	Process	2.27	Treated effluent to infiltration pit.
PE4256	Border Sand	BB	Gravel	Process	2273	Gravel washwater to settling pond
PE4645	Del-Van Constr.	BB	Municipal	Sewage	123	Treated effluent to tile field.
PE4690	Old Yale Invest.	BB	Food	Process	114	Treated effluent to spray irrigation.
PE4902	Dayhu Invest.	NA	Municipal	Sewage	22.7	Treated effluent to tile field
PE4962	Hilinex	NA	Forest	Process	0.5	Treated process water to infiltration pit.
PE4963*	Somerville Bel	NA	Forest	Process	15.7	Treated process and washwaters to infiltration ponds.
PE5478	Sunnyside Villa	BB	Municipal	Sewage		Treated effluent to tile field.
PE5496	Hancy Corr. Ctr.	MS	Municipal	Sewge	70	Treated effluent to tile field.
PE5500	Rempel Bros.	MS	Concrete	Process	55	Washwater to infiltration pond
PE5529	B.C. Hydro	MA	Petroleum	Process	2.7	Treated vehicle maintenance shop washwater to rock pit.
PE5833	Construction Ag	NA	Concrete	Process	16.2	Truck wash to infiltration pond.
PE6323	School District 35	BB	Municipal	Sewage	24.5	Treated effluent to tile field.
PE6524	Rebar Redi mix	NA	Concrete	Process	5	Truck and aggregate washwater to infiltration pond.
PE6814	Rempel Bros	NA	Concrete	Process	55	Truck wash to infiltration pond.
PE6943	Spincraft	MA	Metal	Process	5	Treated rinse tank effluent from metal cleanup to infiltration pit.
PE7582	J&L Meats	BB	Food	Process	6	Treated effluent to tile field.
PE7815	Hancy Corr. Ctr.	MS	Municipal	Sewage	194	Treated effluent to tile field.
PE7880	A.G. Meynders	MS	Municipal	Sewage	0.54	Treated effluent to tile field.
PE8031	BCMOP	MS	Municipal	Sewage	20.55	Treated effluent to tile field.
PE8094	May and Sons	MA	Municipal	Sewage	45.5	Treated effluent to tile field.
PE8106	S. Hardman	MS	Municipal	Sewage	1.4	Treated effluent to tile field.

* Multiple discharges with this permit.
ND no data

(Source: WMB files)

Table 12.2 LANDFILL SITES

Large Active Municipal Landfills

No.	Name	Affected Water Body	Estimated Flows*	Comments
PR7611	Burns Bog	Main Arm	1200	Leachate collected, discharged to sewer
PR1686	Port Mann	Main Stem	600	Leachate collected, discharged to sewer

* In m^3/day, flows approximately double during heavy rainfall.

Large Closed Municipal Landfills

No.	Name	Affected Water Body	Estimated Flows*	Comments
PR4385	Braid Street	Main Stem	1000	Monitored
	Leeder Avenue	Main Stem	1000	Monitored
	Kerr Road	North Arm	500	Leachate collected, discharged to sewer
PR4922	Richmond	Main Arm	5000	Leachate collected, treated onsite
	Stride Avenue	North Arm	200	Monitored
	Terra Nova	Main Stem	600	Leachate collected, discharged to sewer

* In m^3/day, flows approximately double during heavy rainfall.

Small Municipal Landfills

Name	Affected Water Body	Status	Leachate Impacts
PR1710 Cottonwood, Maple Ridge	Main Stem	Open	Yes, sewer discharge.
Johnston Road, Surrey	Main Stem	Closed 1969	Yes
Bear Creek, Surrey	Serpentine River, Bndy Bay	Closed 1967	Yes
Elgin, Surrey	Nicomekl River, Bndy Bay	Closed 1 56	Unknown
Port Coquitlam	Coquitlam River, Main Stem	Closed 1979	Unknown
Sperling Avenue, Burnaby	Brunette River, Main Stem	Closed 1967	Unknown
Semiahmoo Bay, Surrey	Campbell River, Bndy Bay	Closed	Unknown
24th Avenue Surrey	Nicomekl River, Bndy Bay	Closed	Unknown

Table 12.3 WMB REFUSE PERMITS

PERMIT	NAME	R	REFUSE TYPE	Volume (m^3/day)	COMMENTS
PR1655	Canadian Forest Products	MS	Ash, sand, and gravel	3	High pH, alkalinity
PR1667	MacMillan Bloedel	NA	Ash, sand, slag,charcoal	15.3	Closed May, 1977
PR1685	United Auto Wrecking	MS	Demolition, metal scraps	760	Leachate generated
PR1910	Parsons Channel Prop.	MS	Sawmill wood wastes	920	
PR2085	Letson and Burpee Ltd		Foundry waste, sand, gravel	3	
PR2086	Western Canada Steel	NA	Ash, cinders, bricks, metal	13.8	Dormant from July, 1988
PR2259	Pacific Disposal Ltd		Demolition mixed inert	38.2	Cancelled July 29, 1986
PR2351	Kennametal Inc	MS	Ash, refractory brick	1	Leachate probably toxic
PR2425	Weldwood of Canada Ltd	NA	Ash, sand, 4% paint and glue	2.3	Leachate probably toxic
PR2510	Bow Valley Res. Services	NA	Ash, sand, gravel, sludge	3	
PR2550	Reliance Foundry Co Ltd	BB	Foundry waste, sand, gravel	5	Leachate high in metal contamination
PR2989	BCMOP	MS	Municipal type	3/week	
PR3082	Rober Industries Ltd		Foundry waste, sand, gravel	0.76	Now closed.
PR3141	Crane Canada Ltd	MS	Porcelain/clay products	2.3	
PR3417	Domtar	MS	Sawdust, bark, yard refuge	6.5	
PR3867	Con-Force Structures Ltd	MA	Cement wastes, sand, wood	11	
PR4409	Lafarge Canada Ltd	MA	Cement wastes, sand, wood	54	
PR4428	Baytree Industries	MS	Demolition debris, woodwaste	7.6	Fill completed
PR4441	Cloverdale Demolition	BB	Demolition debris, woodwaste	17.6	Dormant from Mar 20, 1980
PR4468	Vito Steel and Barge	MA	Gyproc, woodwaste	unspecified	Leachate highly toxic
PR4923	Peter Lavigne	MA	Asphalt waste	7.6	
PR4971	Delta Cedar Products	MA	Woodwaste	153	
PR5031	Fletcher Challenge	MS	Municipal type	2.3	
PR5135	Mr and Mrs White	MA	Asphalt waste	7.6	Not used
PR5358	G.B. Lawrie	MA	Woodwaste	229	
PR5443	District of Burnaby	NA	Woodwaste	260	
PR5936	Paperboard Industries	NA	Paper fiber, sand, wood, metal	5.5 tonnes/d	
PR6574	Meadowland Peat Ltd	NA	Demolition debris, woodwaste	400	
PR7276	District of Burnaby	NA	Woodwaste, clean fill	max 93,000m^3	
PR7707	Alpha Manufacturing	MA	Demolition and excavation	320	
PR7709	7437 Holdings	MA			
PR7765	Robert Brown	MA	Demolition debris	75	
PR8139	Meadowland Peat Ltd	MA	Demolition debris	240	
PR8169	Robert Brown	MA	Inert industrial	300	
PR8177	ADP Holdings	MA	Inert industrial	50	

Note: probable leachate generation to groundwater for all except cement plant wastes and porcelain wastes.

(Source: Atwater, 1980:Table 6.3.1, updated from WMB files)

Table 12.4 LEACHATE LOADINGS FROM LARGE MUNICIPAL LANDFILLS, 1979

Parameter	Active	Closed
COD	4,800	110
Chloride	2,285	72
Ammonia	523	27
Iron	153	6
Manganese	28	1.3

In kg/day

(Source: Atwater, 1980: table 7.6)

Table 12.5 MUNICIPAL LANDFILL LOADINGS, 1985

Parameter	Burns Bog	Coquitlam	Cottonwood	Kerr Road	Port Mann
Total Solids		1,437		507	1,289
Suspended Solids	131	42			100
Oil and Grease		5			
COD	538	329	58	42	288
BOD_5		23	<9		74
TOC			99	17	107
Phenol	<0.7	0.059		0.001	
Chloride		278			180
Fluoride*	<.01	0.1			0.07
Sulphate*	81	18			4.2
Sulphide	<0.1	<0.06			
Total Kjeldahl N		131			93
Ammonia	289	128	13	24	79
Nitrate	5	0.9	0.11	3	
Nitrite	0.1		0.018	0.051	
Phosphate*		0.6			0.14
Aluminum*		<0.3	0.9	0.02	
Arsenic*	<0.1	0.03	<0.2	<0.12	0.002
Barium*			0.1	26	
Boron			0.4	0.95	
Cadmium*	<0.1	<0.004	<0.013	<0.005	0.001
Calcium*	210	108	60	41	171
Chromium*	<0.1	<0.03	<0.02	<0.005	0.003
Cobalt*		<0.03	<0.01	<0.049	
Copper*	<0.1	<0.012	<0.008	<0.005	<0.16
Iron*	17	18	2.3	0.1	37
Lead*	<0.8	<0.045	<0.04	<0.049	0.16
Magnesium*		30	16	19	32
Manganese*	2	1	0.9	0.1	1.1
Mercury	<0.0007	<0.0003	<0.02		
Molybdenum*		<0.06	<0.013	0.01	
Nickel*	<0.1	<0.03	0.3	<0.025	0.01
Phosphorus			10.6		0.6
Silver*		<0.012	<0.02		
Sodium*		154	36		129
Vanadium*			<0.005	<0.005	
Zinc*	0.25	0.062	0.02	0.007	0.26

Notes:
Units in kg/day
* May be total or dissolved
Blanks indicate no data.

(Source: GVRD, 1988d, App. E)

Table 12.6 ESTIMATED LOADINGS FROM SEPTIC TANKS

Reach	Residences (estimated)	Loadings (kg/year) BOD	Suspended Solids	Ammonia	Fecal Coliforms ($\times 10^{15}$)
FRASER RIVER					
North Arm	15	315	315	30	0.3
Main Arm	120	2,520	2,520	250	2.4
Kanaka Creek	900	1,890	1,890	190	1.8
Pitt River	2,000	4,200	4,200	420	4
Coquitlam River	300	630	630	65	0.6
BOUNDARY BAY					
Serpentine River	1,300	2,730	2,730	275	2.6
Nicomekl River	1,200	2,520	2,520	250	2.4
Campbell River	1,100	2,310	2,310	230	2.2

Except for the Fraser River, it is assumed that only 10% of the actual loadings could enter the waterbody.

(Source: GVRD, 1988b: table 5.8)

Appendix 13 Miscellaneous Wastes

13.1 Introduction:

Miscellaneous wastes are discharges from floating homes, liveaboards, shipping, accidental spills, illegal dumping, atmospheric deposition, dredging and dumping of contaminated sediments, contaminants entering the estuary from upstream sources, and other discharges of potentially deleterious or toxic substances that are not included in previously discussed areas of concern. Generally, contaminant loadings from these sources are minor, but significant localized impacts may result.

13.2 Area Characteristics and Flows:

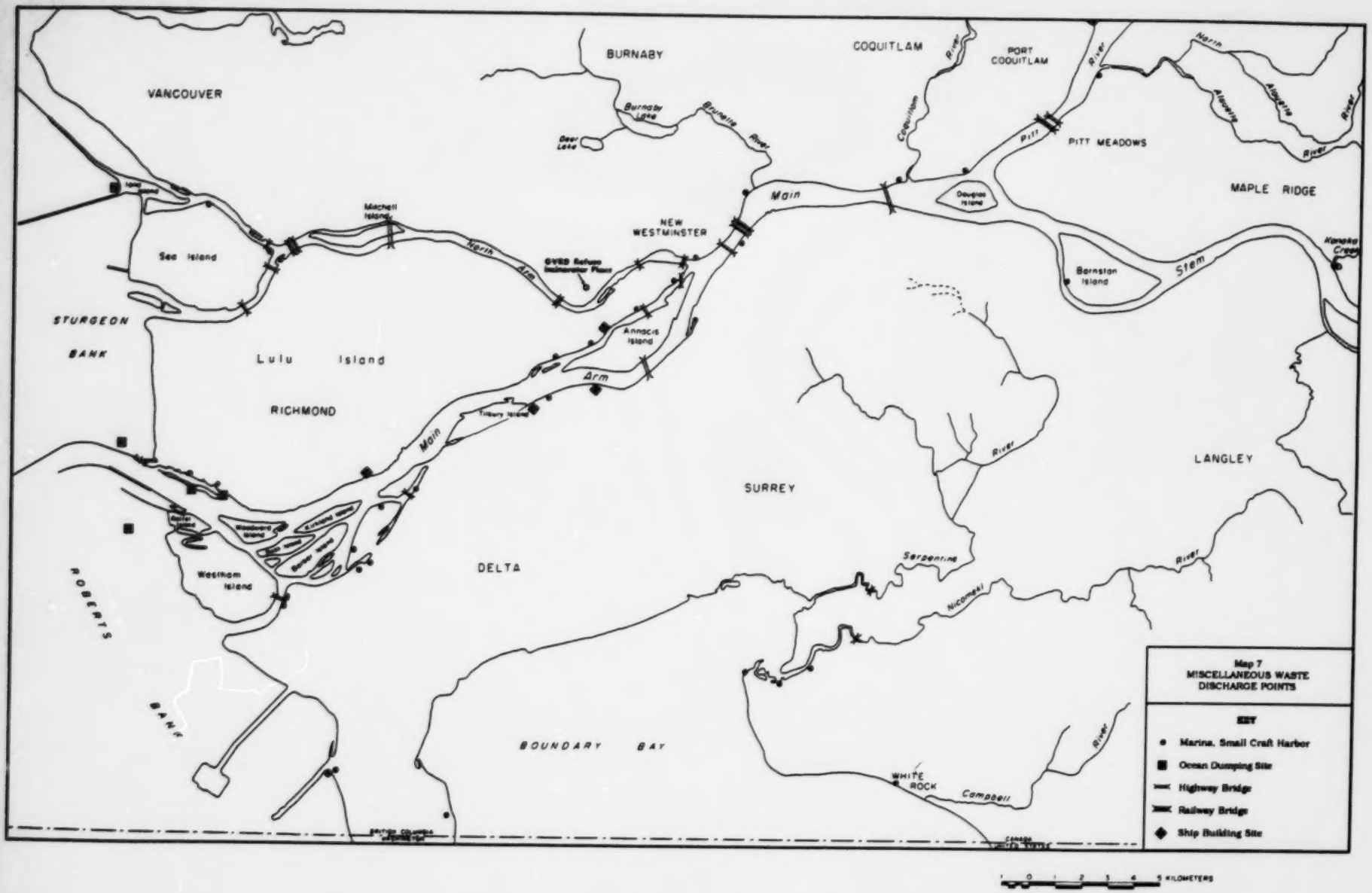
Fraser River marinas and small craft moorages are found at the bifurcation of the North Arm at Sea Island, Annacis Island, the south shore of the Main Arm between Deas and Westham Islands, and Steveston. There are a few along the Main Stem, and, in Boundary Bay, at the mouth of the Serpentine River at Cresent Beach. These marinas are used by pleasure craft, tugboats, fishboats, liveaboards, and floating homes. According to the LWMP Water Use/Water Quality Committee (GVRD, 1988e) there are 25 liveaboards on Dyke Road in Richmond opposite Sea Island, 10 at Captain's Cove, Deas Island on the lower Main Arm, 43 at the Canoe Pass Floating Village, 4 at Shelter Island on the upper Main Arm, 3 at the Pitt Meadows Marina on the Pitt River, and 2 at White Rock. The WMB has issued five permits to marinas or floating home developments, including Canoe Pass. Other marinas are connected to municipal sewer, some are unauthorized. Fishboats may also discharge wastes at various small craft moorages or at fish plant docks. At limited locations in the estuary, ship building or maintenance activities are performed. Metal based blasting abrasives, old paint debris, and solvents may be released from these sources. Metals and organics accumulating in sediments may cause biological toxic response.

Estuary port facilities primarily serve lumber industry traffic in the North Arm, and international trade at Annacis Island on the Main Arm. Freighters and cruise ships occasionally dock at New Westminster on the Main Stem, and log booms and barges are ubiquitous. There is a major bulk loading facility on Roberts Bank. Discharges from the port facilities themselves are considered as industrial effluents and most are regulated by WMB permit, but bilge or holding tank discharges and cargo spillage occur at dockside and during transit.

Oil and chemical spills are most likely to originate from fuel transfer mishaps or tank leakages involving several hundred liters or less of petroleum products. Large discharges from vessel collision or grounding, or tank or pipeline rupture are rare. There were 61 reported spills during 1984-1986 downstream of Kanaka Creek, most resulting from accident and negligence (Solsberg, 1988; FREMP, 1987).

Unauthorized or illegal dumping of liquids or solids occurs at random locations. This ranges from illicit "midnight" disposal of toxic wastes to small streams or tributaries which may have a dramatic local impact such as a fish kill, to aesthetically displeasing "convenience" dumps of litter and other solid wastes. Such solid waste dumps are subject to leaching which may deliver contaminants to receiving waters. Some industrial discharges exist whose operators do not realize that permits are required. Examples are truck wash of excess concrete dumped in foreshore yards at the end of the day. Approximately twenty concrete companies exist along the river, only four have permits for discharges to ground. Concrete plant discharges are of concern because Fraser River water has poor buffering capacity for alkaline contaminants.

Acid rain is an atmospheric deposition concern that has received much recent attention. Other materials deposited can include such priority substances as dioxins, furans,


VANCOUVER
BURNABY
COQUITLAM
PORT COQUITLAM
PITT MEADOWS
MAPLE RIDGE
NEW WESTMINSTER
Sea Island
Lulu Island
RICHMOND
STURGEON BANK
ROBERTS BANK
Westham Island
DELTA
SURREY
LANGLEY
BOUNDARY BAY
WHITE ROCK
Annacis Island
Barnston Island
Douglas Island
Burnaby Lake
Brunette River
Coquitlam River
Pitt River
North Arm
Main
Arm
Stem
Serpentine River
Nicomekl River
Campbell River
Kanaka Creek
Alouette River
Harris
Map 7
MISCELLANEOUS WASTE DISCHARGE POINTS
KEY
Marina, Small Craft Harbor
Ocean Dumping Site
Highway Bridge
Railway Bridge
Ship Building Site
0 1 2 3 4 5 KILOMETERS

chlorophenols, lead, pesticides, and other metals and organics. Sources are combustion of wood as in forest fires, slash burning, or woodwaste incineration; burning of fuels such as leaded gas; industrial discharge of waste gases; residential or commercial spraying of pesticides; wearing of tire rubber on roads; and others. These substances can then be washed into the river by storm events. As reported in Appendix 10, both Swain (1983) and Lawson et al. (1985) found dustfall and precipitation to be significant sources of contaminants in both residential and industrial sites in the study area.

Dredging occurs along North and Main Arms to maintain shipping channel depths and to deepen log ponds and wharf areas at forest products operations. Sediments are a known contaminant sink, and the potential for contaminated sediment transport leads to concern over their disposal. Dredge spoil piles are located at Sand Heads, which includes the mouth of the Main Arm on either side of the jetties and at east and west ends of Steveston Island. The Point Grey disposal site is located on the Iona Island north side spit. Dredged quantities range between 8 and 26 million tonnes per year (Stewart and Tassone, 1989). The Regional Ocean Dumping Advisory Committee (RODAC) reviews applications for disposal of dredged material at these sites, and determines whether sediment contaminant levels meet regulatory limits under the Canadian Environmental Protection Act. The Schedule III list of prohibited substances includes mercury, cadmium, oil and grease, and organohalogens. The list of restricted substances includes arsenic, lead, copper, zinc, and organosilicon and their compounds, and pesticides. In general, upstream transported sediments are within regulatory limits, but sediments contaminated by anthropogenic activities may exceed these limits. Dredgate may also be used for filling foreshore areas prior to development.

Pollutants entering the river upstream of Kanaka Creek may contribute to estuary loadings. Little information exists that would allow differentiation between natural and anthropogenic origins of these upstream contaminants.

Sandblasting and repainting of bridges involves discharges of sand and paint particles into receiving waters, possibly impacting fish resources. Fine particles of sand may clog gills, paint or other contaminants may be toxic. Federal guidelines or protocols of practice suggest that sand be clean and not contain slag, that minimum amounts be used, that lead dust be collected, that non-toxic paints be used and overspray minimized, and that seasonal timings be adhered to.

Preservation treatments for boats, pilings, wooden river training walls, and other water contacting structures contain substances that contaminate receiving waters. Of concern are organotins such as tributlytin (TBT) from antifouling paints used on boats, and creosote substances used for wood preservation. Levels of PAHs may be high near creosote treated wharves and pilings. Concentrations of TBT are highest near marinas however the levels have not been monitored and environmental impacts from this substance are not well defined in the Fraser Estuary.

13.3 Loadings:

The LWMP Combined Sewer Overflow and Urban Runoff Committee (GVRD, 1988b) estimated loadings from marinas by assuming pleasure and commercial craft would discharge 45 L/d/person for two people 10 days per year, and that liveaboards would discharge 1,136 L/day/unit 365 days per year. Contaminant concentrations in the discharge were assumed equal to Lulu Island STP influent sewage (Table 13.1). Loadings from freighters and cruise ships could be estimated on a discharge of 0.23 m^3/day/person basis with concentrations as for the Lulu STP influent sewage, but the number of persons is not known with any accuracy. No other quantified loading estimates exist for miscellaneous waste discharges to the Fraser estuary.

Table 13.1 ESTIMATED LOADINGS FROM MARINAS

Reach	BOD5		NFR		Ammonia		Fecal Coliforms	
	P+C	F+L	P+C	F+L	P+C	F+L	P+C	F+L
Boundary Bay	0.01	0.2	0.01	0.2	0.001	0.02	6.2	199
Pitt River	0.03	0.3	0.03	0.3	0.003	0.03	33.4	299
Main Stem	0.003	2.5	0.003	2.5	0.0003	0.3	2.6	2490
Main Arm	0.3	5.8	0.3	5.8	0.03	0.6	329	5580
North Arm	0.2	3	0.2	3	0.02	0.3	177	2890

P = pleasure craft, C = commercial, F = floating homes, L = liveaboard
Note: these figures in kg or no. per year PER UNIT.

(Source: GVRD, 1988b)

13.4 Issues:

The overriding issue associated with these miscellaneous waste discharge streams is the regulative and enforcement strategy of government agencies. A variety of legislation covers many of these cases: the provincial Litter Act, Waste Management Act, and Health Act, and the federal Fisheries Act and Canadian Environmental Protection Act. For particular cases, issues may involve legislative interpretation, regulative procedure, or enforcement. Questions of jurisdiction may need to be settled before action can be taken, as for atmospheric deposition and liveaboards. Lack of information is also an issue, as for the use of antifouling paints and wood preservatives.

Some of these topics are being addressed within other projects. Monitoring for background contaminants carried into the estuary from upstream is being addressed by the Standing Committee on the Fraser River Estuary Water Quality Plan. This study will help differentiate between contaminants of natural and anthropogenic origin. Dumping of contaminated dredgate is controlled by the Canadian Environmental Protection Act, and the Inland Waters Directorate, DOE, has identified areas of contaminated sediments. Spills and spill response are covered by the Emergency Management Activity Program. Issues discussed below include houseboat, shipping, atmospheric deposition, and unauthorized dumping situations.

Discharges from floating homes and liveaboards are covered under both the Waste Management Act administered by MOE, and the Health Act administered by MOH. A problem of interpretation exists here as MOH feels that the WMB of MOE is responsible for discharges to water, while the WMB feels MOH is responsible for not allowing discharges of raw sewage from single family dwellings, which would include discrete houseboat and liveaboard units. Where floating homes and liveaboards are connected to services such as in a marina, WMB permits are issued when the operator applies for them. Some marina operations are unauthorized as the operator has not applied for a permit. This situation is compounded by lack of municipal regulation of these sites.

Also subject to questions of jurisdiction are discharges from pleasure craft, commercial boats, and other shipping. These could be regulated under the Canada Shipping Act if enforcement under provincial statutes is deficient. The Canada Shipping Act would classify wastes subject to regulation and classify the waters where restrictions apply. Amendments to the act have not been enacted.

Atmospheric deposition is a concern for which little information exists. It has been recognized as a source of contaminants, but significance and environmental impacts are only beginning to be realized. The largest impact appears to be on stormwater quality. If stormwater contamination is to be addressed at source, atmospheric deposition will need to be examined.

Unauthorized dumping is primarily a regulation and enforcement problem. Convenience dumping is covered under the Litter Act, illegal discharges of deleterious

substances under the Fisheries Act and the Waste Management Act, but enforcement is difficult. Discharge of cement truck wash water is discussed in Ross and Shepard (1988), often operators may not be aware that a permit is required. In these cases the permit procedure acts as a check to ensure that environmental impacts are minimized.

13.5 Initiatives:

The FREMP Emergency Response Activity Program has let contracts regarding spill response equipment needs and actions (see Solsberg, 1988). Both DOE and MOE have programs in place to respond to spills as they are reported, such as the Provincial Emergency Program (PEP).

A project studying the atmospheric deposition of chlorophenols has been undertaken by the Inland Waters Directorate of DOE. Leaded gas, a source of atmosphere deposited lead, now costs more than unleaded due to changes in the tax structure. This removes cost incentives to prefer leaded fuel. Atmospheric emissions monitoring in the region is delegated to the GVRD via the Waste Management Act (Sec. 19). The GVRD runs a series of monitoring stations and publishes regular emission reports. Industries emitting air pollutants are required to obtain a permit and maintain certain standards.

The North Fraser Harbour Environmental Management Plan is considering water quality action options which include a Harbour Patrol Surveillance scheme to detect illegal pollution sources (Williams, 1988). This includes harbor patrols watching for dumping of garbage or debris, suspicious or suspected illegal discharges, and the like. Incidents are to be recorded and the proper agency notified.

Environmental Protection has initiated a project to develop "best management practices" for major ship yards in British Columbia. Vito Steel Boat and Barge Construction Ltd., located on the Main Arm, is the only FREMP area company directly affected, though other boat building and repair facilities exist in the estuary.

13.6 Remedies:

The issue of sewage from floating homes and pleasure craft could be resolved through a committee with representation from MOE, MOH, EP, and the affected municipalities. FREMP could facilitate the formation and work of the committee. Topics could include interpretation of the Waste Management Act and the Health Act such that houseboat and liveaboard effluent regulations can be enforced. Municipal enforcement of their relevant bylaws might be discussed. Terms of reference for this committee might be extended to shipping discharges. The committee could also identify miscellaneous waste streams that are not currently being monitored or addressed by codes of practice and bring these to the attention of the relevant agency for action.

The Waste Management Activity Plan needs to assist in the implementation of a mechanism for harbor patrol and surveillance in order to deal with the issue of illegal dumping. The suggestions of the North Fraser Environmental Management Plan for surveillance should be discussed by FREMP members and adopted on a wider scale if proven effective.

Monitoring of TBTs and similar water contact contaminants needs to be further examined by Environment Canada. Estimates of usage, environmental effects and significance, areas of impact, chemical pathways, alternatives, and water quality monitoring programs are all subjects that need addressing. A bridge sandblasting code of practice has been developed, but its effectiveness still needs to be monitored.

Monitoring of upstream contaminants should be undertaken as recommended by the Standing Committee on the Fraser River Estuary Water Quality Plan. Differentiation between natural and anthropogenic upstream contaminants needs to be made. A determination of the extent of masking of contaminants introduced from the Greater Vancouver area by upstream contaminants should be considered.

An investigation of atmospheric deposition pollutants and their significance should be undertaken. Needed is characterization of deposits and their sources, environmental effects, and areas of impacts. Actions towards reducing atmospheric emissions should be taken. An example of such an action is the cessation of leaded fuel sales. Research into alternative emission reduction measures such as taxes, incentives, restrictions, and regulations should continue.

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Glossary

Acute toxicity
Severe biological harm or death produced by a short exposure (usually 96 hours or less) to a substance or mixture of substances. See also Chronic toxicity, 96 hr LC50.

Algal bloom
Occurs when excessive nutrient levels and other water conditions enable rapid growth of algae populations.

Ambient
Normal conditions in the surrounding environment.

Ambient standard
A standard which considers the effects of different pollutant loadings on the physical, chemical, or biological properties of the receiving water or air medium. See also Technology-based standard.

Analytical protocol
Methods for sample analysis and quality assurance used for the collection of environmental data

Anthropogenic
Relates to or involves the actions or impact of man.

Antifoulant
Any substance used to repel or destroy organisms that inhabit or foul the bottom of commercial and recreational boats or other marine structures.

Average dry weather flow
The average flow that a sewage treatment plant experiences in dry weather.

Assimilative capacity
The quantity of wastes that can be discharged to waterbodies or air masses without violating a specified standard of quality. See also Ambient standard.

Best management practice
A method for preventing or reducing the amount of pollution generated by an activity.

Bioaccumulation
The uptake, retention, and concentration above background levels of chemicals or metals in an organism from its environment.

Bioassay
A test procedure that measures the response of living plants, animals, or tissue to a sample. See also 96hr LC50.

Biodegradation
The conversion of organic compounds into simpler compounds through biochemical activity.

BOD5
The amount of oxygen used in the oxidative decomposition of a material by microorganisms over five days at a standard incubation temperature.

Buffer
A compound or solution capable of resisting a change in pH.

Carcinogenic
Capable of causing cancer.

Chlorophenols
Chlorinated phenol compounds used as toxic fungicides to treat and preserve fresh wood.

Chronic toxicity
A long-term toxic effect produced in an organism by a substance or mixture of substances.

Clarified effluent
Effluent that remains after sediments have settled and surface scum removed.

Coliforms
A group of bacteria used as an index of possible disease organisms in water. Total and fecal coliforms may be measured. See also Pathogenic Micro-organism.

Combined sewer
Sewer system combining sanitary wastes and storm waters into the same pipe.

Combined sewer overflow
Overflow of stormwater diluted sewage during storm events.

Contaminant
A substance that is not naturally present in the environment or is present in amounts that can, in sufficient concentration, adversely affect the environment. Not necessarily harmful. See also Pollutant.

Conventional pollutant
Contaminants for which pollution abatement activities have traditionally been addressed. See also Priority Pollutant, BOD5, NFR, Nutrient, Coliforms.

Cumulative effects
Combined environmental impacts accruing over time and space from a series of similar or related individual actions, contaminants, or projects. Though individually negligible, combined impacts can be severe.

Diffuser
Port and riser structure attached to end of submerged outfall to enhance IDZ dilution.

Disinfection
The process of destroying microorganisms in water by application of a disinfectant such as chlorine.

Dry pond
Landscaped area designed for temporary storage of stormwaters allowing some settling of sediments.

Dry well
A pit in the ground, often filled with gravel, to which stormwater is routed to be held until it percolates into the ground. See also Infiltration pit.

Effluent
Liquids, usually contaminated water, discharged to the receiving environment.

Estuary
Interface between land, atmosphere, freshwater, and the sea.

First flush effect
Higher concentration of stormwater contaminants found in first 1 to 3 hours of runoff from a storm event.

Fraser River Estuary
Generally accepted as the land and water area on the awetted side of dykes downstream of Kanaka Creek and the outlet of Pitt Lake, and including Roberts and Sturgeon Banks and Boundary Bay.

Freshet
Annual May - June peak river flows due to melting of snow in the interior.

Groundwater
Underground flows of water, such as aquifers, replenished by precipitation and flowing towards rivers, lakes, or the ocean.

Health risk
The risk or likelihood that a person's health will be adversely affected.

Infiltration pond or pit
Uncovered reservoir designed to accept effluents and allow infiltration to groundwater.

Influent sewage
Flows collected in sanitary or combined sewers and directed to sewage treatment plants for treatment.

Initial dilution zone
Zone of initial mixing adjacent to an effluent outfall. Generally expressed in terms of downstream distance and width in the case of a river.

Intermedia transfer
Exchange of contaminants between or among media, as a treatment method that transfers a volatile compound from wastewater to air.

Kjeldahl nitrogen
Sum of organic and ammonia nitrogen.

Leachate
Solution of water-soluble compounds resulting from the infiltration of water through overlying materials.

Loading
The amount of a contaminant deposited or discharged to the receiving environment, expressed as kilograms per day or per year.

Mutagenic
Capable of causing biological mutations.

Nutrient
An element or compound necessary for the growth and development of organisms.

Oncogenic
Capable of causing the formation and development of tumors.

Organics
Classes of substances containing molecules built about the carbon atom. May be toxic and persistent in the environment. See also Priority pollutant, polychlorinated biphenyls.

Pathogenic micro-organism
Waterborne bacteria, viruses, protozoa, and fungi causing diseases such as typhoid fever, cholera, infectious hepatitis, dysenteries, and other varieties of gastrointestinal disease, present in poorly treated human sewage adn animal wastes. See also Coliforms.

Peak wet weather flow
Maximum flow that can be handled by sewage treatment plants, usually occurring during wet weather.

pH
Negative base 10 log of hydrogen ion concentration where 7.0 is neutral, lower values are acidic, and higher values are alkaline.

Pollutant
A contaminant that is destructive or has a negative environmental impact. See also Contaminant.

Pollution
The modification of the properties of water or air--either naturally or though human action--so as to reduce the utilities normally derivable, referred to as a cost or damage.

Pollution control objective
Guideline for effluent quality to assist the drafting of discharge permits.

Polychlorinated biphenyl
Man-made liquid chemicals that are stable, noncorroding, fire-resistant, and nonbiodegradable. Once used in electrical equipment because of these properties.

Primary sewage treatment
Removal of settleable or floating solids through screening, filtering, and settling; some metals and BOD reduction, coliform reduction with chlorination.

Priority pollutant
Metals, inorganics, and organics that are toxic, persistent, bioaccumulative, and/or environmentally mobile that are listed by regulatory agencies (e.g. DOE, under CEPA, in Canada, EPA in the US) as priorities for testing, analysis, and possibly regulation.

Rural runoff
Stormwater drainage in rural and agricultural areas.

Sanitary sewer
A pipe carrying domestic and nondomestic wastewaters to treatment facilities.

Secondary sewage treatment
Extends primary sewage treatment to remove additional contaminants via chemical or biological means.

Sediment pond
Uncovered reservoir designed to accept effluents or stormwater flows and allow settlement of materials before draining. Periodic removal of settled sediments is required. See also Wet pond.

Separate sewer
Sewer system with domestic wastes in one pipe, and stormwater in another.

Sewage treatment plant
A facility that treats influent sewage to remove contaminants. See primary sewage treatment, secondary sewage treatment.

Side channel
Slow moving body of water usually with two ends open to the main channel.

Slough
Slow moving body of water usually with one end open to the main channel.

Sludge
Semi-liquid by-product of sewage treatment, contains materials removed during treatment.

Source control
Regulation of nondomestic discharges to municipal and regional district sewage facilities.

Special waste
Dangerous goods that require special treatment or storage prior to disposal.

Storm sewer
A pipe carrying precipitation runoff.

Stormwater
Precipitation runoff. See also Rural runoff, Urban runoff.

Synergism
Combined activity such that the whole effect is greater than the sum of the parts.

Technology-based standards
Effluent quality standards developed by considering technologically achievable procedures and their cost. See also Ambient standard.

Teratogenic
Capable of causing birth defects.

Urban runoff
Stormwater flowing from urban areas, where natural stream courses are replaced by pipes, and impervious surfaces lead to more rapid runoff and higher peak flows.

Water Quality Objective
Criterion or Guideline adapted to protect the most sensitive designated use at a specific location with an adequate degree of safety, taking local circumstances into account.

Wet pond
Uncovered reservoir designed to retain stormwater flows until the next storm, settlement of sediments occurs between storms. See also Settlement pond, Dry pond.

96 hr LC50
The concentration of a contaminant causing 50% mortality of a fish test species after 96 hours.